Vol. 15, No. 12 December, 1959

LUBRICATION ENGINEERING

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Drums along the...

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Volume 15, No. 12
December, 1959

Lubrication Engineering

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

Contents

LUBRICATION IN PRACTICE

Specification of Circulating Oil Systems ..... J. B. Kirschner 484

DESIGN, RESEARCH, DEVELOPMENT

High-Temperature Friction and Wear Properties of Bonded Solid Lubricant Films Containing Lead Monoxide
R. L. Johnson and H. E. Sliney 487

Conditioning of Vacuum Pump Oils ..... G. Topol 492

CURRENT NEWS

Industry Notes 470

Lubrication in the News 470

Personals 474

Section News 476

EDITORIAL TOPICS

Author and Title Index 1959 505-506

Our Society ..... A. B. Wilder 483

Letters to the Editor 479

Lube Lines 481

LITERATURE SUMMARIZED

ASLE Technical Digest 497

Lubrication Abstracts 500

Patent Abstracts 502

TRADE INFORMATION

Advertisers' Index 508

New Products 472

Cover photo courtesy Inland Steel Company

Abstracted by Engineering Index and Industrial Arts Index

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LUBRICATION IN THE NEWS

The Society will not be responsible for the accuracy of statements made in this column. Any reference to proprietary products does not imply an endorsement of such products by the Society.

Company Sets Up Scholarship

A leading chemical corporation announced the establishment of a college scholarship foundation for children of its employees.

The corporation will make available one or more scholarships each year to outstanding high school seniors. These will be scholarships granted for undergraduate study and leading to a Bachelor's Degree in the Technical and Liberal Arts fields in any accredited United States college or university. They will be awarded to seniors who not only attain high scholastic standing but also have demonstrated the qualities of leadership, integrity and industry.

Such scholarships will be available beginning June, 1960 and will provide a yearly maximum of $1,500 per recipient with a total not to exceed $6,000 per recipient. (*Source: Quaker Chemical Products Corp., Conshohocken, Pa.*)

Viscometer Gives Greater Accuracy

A new automatic instrument is reportedly providing greater accuracy and reliability in measuring the viscosity of photographic emulsions at a photo-film manufacturing company.

The instrument is described as a rolling ball viscometer in a paper given in September before the annual meeting of the American Chemical Society in Atlantic City, N. J.

The viscometer consists of a precision glass tube, mounted in an inclined position in a temperature-controlled water bath, the scientists said. The tube is filled with the liquid to be measured, and a steel ball, with a variation in size of less than 6/100,000 of an inch, is dropped into it.

The time taken by the ball to travel the distance between two magnetic coils that surround the tube near the top and bottom is a measure of the viscosity of the liquid.

Since the ball is steel, changes it causes in each of the magnetic fields start an electronic clock when the ball passes through one field and stop it when it enters the other. The time of passage is thus measured very accurately.

The company has no present plans to manufacture or sell the instrument. (*Source: Eastman Kodak Company, Rochester, N. Y.*)

Cichelli Given AISE Award

The Association of Iron and Steel Engineers awarded the third place AISE Kelly Award to A. E. Cichelli, lubrication engineer, Construction Engineering Dept., Bethlehem Steel Co. for his paper, "Mill Gearing as Viewed by a Lubrication Engineer." This paper, published in September, 1958, Iron and Steel Engineer, points out the difficulty in applying small gear design techniques to large steel mill equipment, but discusses how the procedures of AGMA and those of Buckingham, intelligently applied, may indicate when failure may be expected. Cichelli has held many official positions in ASLE and is currently Secretary of the Society.

Foreign Rolling Mills Use U. S. Lubricating System

Steel mills being made for two large German and Italian steel companies will be lubricated by continuous flow oil circulating systems furnished by Dravo Corporation, Pittsburgh.

The company is supplying two Dravo-DeLaval mill lubrication systems to Blaw-Knox Corp. for installation on two mills that the company is building for August Thyssen steel works, Germany. Exact duplicates of the lubrication systems are also being supplied by Dravo for similar mills which Blaw-Knox is manufacturing for the Italian steel concern, ILVA.

News of Other Societies

The National Society of Professional Engineers will hold its winter meeting February 18-20 at the Broadview Hotel in Wichita, Kansas. The annual meeting of the National Society will be held June 8-11 at the Statler Hotel in Boston.

Officers and directors for the forthcoming year were elected at the National Lubricating Grease Institute's 26th annual meeting, in New Orleans at the Roosevelt Hotel, October 25-28. H. A. Mayor, Jr., Southwest Grease and Oil is the Institute's 27th president. F. R. Hart, Standard Oil (California) is vice president, C. L. Johnson, Jesco Lubricants is secretary, and A. J. Daniel, Battenfeld Grease and Oil is serving his eighth consecutive term as treasurer. Elected to the NLGI board of directors for three year terms were W. W. Albright of Standard Oil (Indiana), T. W. Binford of D-A Lubricants, J. J. Coate of Esso Standard, G. Landis of Atlantic, J. W. Lane of Socony Mobil, G. E. Merkle of Fiske Brothers Refining, F. W. Minor of Sinclair, and W. M. Murray of Kerr-McGee.

The Cast Bronze Bearing Institute, a product group of the Non-Ferrous Founders' Society, elected national officers and directors for 1959-60 at its annual meeting October 21 at the Bedford Springs Hotel, Bedford, Pa. New officers are: *President*—William H. Crossman, assistant secretary-treasurer, Randall Graphite Bearings, Inc., Lima, Ohio; *Vice-President*—Carter N. Paden, Jr., secretary, Moccasin Bushing Co., Chattanooga, Tenn.; and *Secretary-Treasurer*—A. G. Eberle, general superintendent, Renewal Service, Inc., Philadelphia, Pa. Elected directors are: three-year term—Mr. Eberle and Paul J. Bauman, vice-president, National Bearing Division, American Brake Shoe Co., Pittsburgh, Pa.; two-year term—Mr. Paden and C. Beckett, president, Beckett Bronze Co., Muncie, Ind.; 1-year term—Mr. Crossman and M. E. Nevins, president, Wisconsin Centrifugal Foundry, Inc., Waukesha, Wis., G. F. Langford, president, Superior Kendrick Bearings, Inc., Detroit, immediate past president, continues as a director for a year.

INDUSTRY NOTES

A new Technical Services office has just been opened by Texaco Inc. in Indianapolis, Ind., it was announced by L. C. Kemp, Jr., vice-president in charge of the Company's Research and Technical Department. Kemp said that the creation of a Regional Office in Indianapolis will make Texaco's research and technical services more readily available to industries throughout the states of Ohio and Kentucky, most of Indiana and southern Illinois. Brian Corrigan, former Assistant to Manager of the Company's central Technical Services Div., has been named regional manager of the new office.

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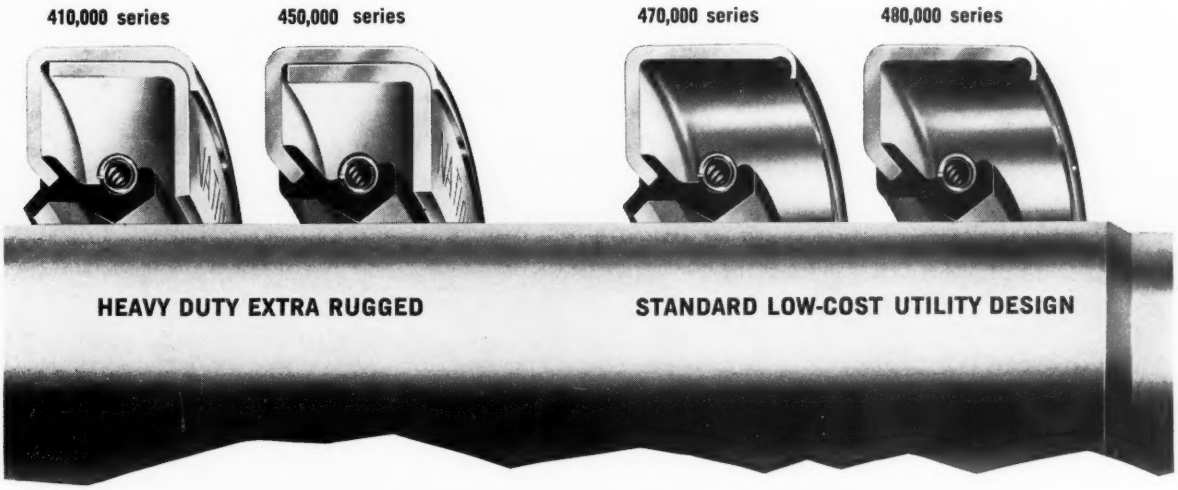

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6071

NEW PRODUCTS

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DIRECT-LIFT SOLENOID VALVE AVAILABLE

A full-ported, direct-lift solenoid valve with port sizes from ¼ inch to 3 inches and capacity from zero to 3,000 PSI has been announced. The 30,000 Series valve, available in bronze or stainless steel, features the new Uramic solenoid that assures reliable operation regardless of line pressures. For complete description, specifications, and application data, write for Bulletin S-1. The Atkomatic Valve Co., Inc., 545 W. Abbott, Indianapolis, Ind.

PORTABLE LUBRICATOR SERVICES PLANT

A permanently air-primed Aro-Pak Portable Lubricator for plant-wide service has been introduced by Aro Equipment Corp. of Bryan, Ohio. The unit may be loaded by the customer's present lube pump, or through use of a filler. It is light in weight, carried by a shoulder strap, holds five pounds of grease and provides one-hand operation for servicing any machines equipped with hydraulic grease fittings. During actual lubrication the lubricator is reported to provide the advantages of a power-operated unit. The control handle is a pressure-boosting type, developing pressure to 7,500 p.s.i. for toughest fittings. One-hand operation allows quick access and servicing on hard-to-reach fittings. Clean grease is automatically delivered to the control handle as rapidly as needed.

IMPROVED SYNTHETIC RUBBER HAS LONGER LIFE

Development of a new type of Viton synthetic rubber has reportedly doubled this product's useful life at temperatures from 500 to 600 F and in certain strong chemicals, it was announced by Du Pont's Elastomer Chemicals Dept. The new version of the jet age elastomer can be used in molded goods and coated fabrics. Tests at 500 to 600 degrees show that useful elasticity is retained up to twice as long. Resistance to special lubricants and hydraulic fluids used in missiles and high-speed aircraft is improved, and useful life is prolonged in the presence of such harsh chemicals as red fuming nitric acid and glacial acetic acid. Viton offered resistance to oils, fuels, and solvents at temperatures above 400 F unequalled by any other commercial elastomer. This made it possible to design applications which had not been possible with other types of natural or synthetic rubber. Development of the higher performance type of Viton is expected to broaden the range of use of the versatile fluorine-containing elastomers. They have been widely adopted for aircraft and missile parts and in a variety of commercial applications in automotive uses, oil well equipment, chemical processing equipment, and household appliances.

SUMP STRAINER PROTECTS HYDRAULIC EQUIPMENT

Development of a Magnetic Sump Strainer to protect hydraulic equipment is announced. Designed to meet the new J. I. C. specifications for magnets in hydraulic systems, the strainer has built-in circular magnets placed between the removable filter discs at specific intervals. The result is reported to be a powerful magnetic field that traps iron filings. Since all the fluid in the system passes through the strainer, the manufacturer claims this location of magnets is the most efficient method.

Available in a wide range of both standard and special sizes, complete specifications and price information may be obtained from: Ripley Screen and Strainer Co., Filter Division, 32749 Northwestern Hgwy., Farmington, Mich.

PRESSURE-LOCKED FILTERS DEVELOPED

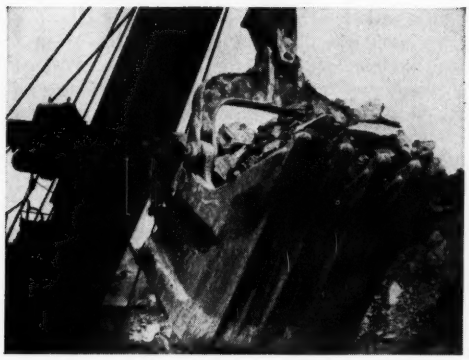
New lightweight filters free of built-in contamination, with media elements locked together mechanically by a specially-developed high pressure process, have been announced. The new high pressure process—using dove-tailed construction—locks together all components of the filter element (including media, end caps, and center tube) securely that the filter medium is embedded in the parent metal of the end caps to form a leak-proof seal. Since the process requires no welding, aluminum and dissimilar metals can be used in filter designs. The company is now producing the pressure-locked filters with stainless steel wire mesh elements, ranging in size from one inch to 1¾ inches diameters. Present ratings are for a nominal ten micron (absolute maximum particle size of 25 micron) and for a nominal five micron (absolute maximum particle size of 15 microns) in capacities of ½, 3, 6 and 12 gpm. Higher capacity elements are being processed for production. Reportedly the new pressure-locked units are designed for all types of filtration including oil, fuel, or pneumatic systems and for any applications where wire mesh filter media of stainless steel, Monel, or phosphorous bronze are required or desired.

For further information concerning the new pressure-locked filter elements, write: Department 108, Purolator Products, Inc., Rahway, N. J.

KIT FINDS CONTAMINANTS IN LIQUID SAMPLES

Complete equipment and instructions needed to take liquid samples from a pressurized system for determining particle contamination are provided in a reportedly new kit. The bomb sampler is plugged into the system to be analyzed. The operating pressure of the system forces a sample of the liquid through the filter and into a graduated plastic bottle.

(Con't. on p. 474)



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NEW PRODUCTS

(*Con't. from p. 472*)

All particles in the sample will be retained on the surface of the filter within the monitor. After sampling, the monitor is disassembled to expose the filter for microscopic examination and counting of particles. The filter disc may be scaled for radioactivity, or weighed to determine the total weight of contaminant. By providing permanent quick-release fittings at sampling points on each system, one of these kits will serve a large number of systems in a given area. Applications include the analysis of liquids in fuel systems, hydraulic test and flush stands, water injection systems for secondary oil recovery, and nuclear moderator and cooling loops. This kit contains all necessary adapters and connections, an all-metal syringe with two-way valve and a carton of 48 field monitors. For further information, write Millipore Filter Corp., Bedford, Mass.

OIL SEAL OFFERS ADVANTAGES

The unitized design of a new oil seal is illustrated in this cross-sectional view of a typical installation. This is a spring-loaded oil seal which has a self-contained wear sleeve. The sleeve turns with the shaft, allowing the lip of the seal to run on the sleeve rather than on the shaft itself. This design, according to the manufacturer, provides a much longer life than conventional seals as well as providing better sealing performance. Further information on Unitseals, including complete technical data, may be obtained from any district office or by writing to National Seal Div., Redwood City, Calif.

ROLLER BEARING SERIES FEATURES CAGE DESIGN

A series of channel-shaped outer ring roller bearings introduced features a new, patented cage design. Utilization of the cage design is claimed to permit application of the bearings at speeds higher than those attainable with full complement types. Longer and larger rollers in these standard inch-size cage-type roller bearings result in greater capacities than heretofore available. Made in sizes ranging from ¾ inch to 4 inches bore, and designated as series HJ, the bearings may be applied directly to hardened and ground shafts or used with inner rings which are also available. Boundary dimensions conform to standard AFBMA series NAA and NAB, and the bearings are interchangeable with needle bearings made to these standards. Roller guidance takes place at the ends of the rollers, and at the pitch line where guidance is most effectively accomplished with minimum friction. Rollers are retained by the middle portion of the cage bar which is always out of contact with the rollers during operation, preventing needless wiping away of lubricant common with ordinary cylindrical cages. Lubricant is allowed to circulate freely through the bearing.

The new design reportedly gives extremely long service life and combines effective roller guidance, minimum internal friction, and provisions for lubrication to allow operation at higher speeds. More detailed information with a complete listing of sizes is now available in catalog 359, available on request from the Torrington Co., Torrington, Conn.

PERSONALS

Robert P. Rice, formerly chief chemist at American Potash & Chemical Corporation's Henderson, Nev., plant, has been transferred to the firm's Los Angeles sales office where he will provide technical sales service to the company's ammonium perchlorate customers.

Lou Albee has been assigned as advertising manager for C. A. Norgren Co., Englewood, Colorado. He is well known in Denver advertising circles and is a national director and past president of the Denver Chapter of the National Industrial Advertisers Association and is a member of the Denver Advertising Club.

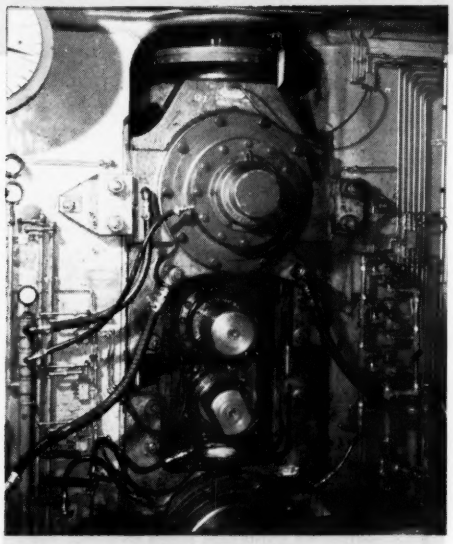
Eric G. Boehm has been designated General Manager of the Manzel Division of Houdaille Industries, Inc. in Buffalo, New York.

L. Richard Malley has been appointed advertising manager of Climax Molybdenum Company, a division of American Metal Climax, Inc. Malley will coordinate the advertising, publicity and sales promotion activities of Climax' several product departments.

Appointment of Paul K. Benjamin, Jr., as product manager, Packing Department, has been announced by Union Asbestos & Rubber Company, Fibrous Products Division, Bloomington, Illinois. In his new capacity, Benjamin will coordinate sales, product development, and manufacturing of all Unarco packing and gasket products.

MORGOIL
BEARINGS

Above: 21" x 56" x 56" 4-High, 4-Stand Tandem Cold Strip Mill
Below: 22½" x 56" x 56" 4-High, Single Stand Temper Pass Mill



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HOLIDAY GREETINGS FROM NATIONAL OFFICE STAFF

The ASLE National Office staff extends warmest wishes to all members and readers of LUBRICATION ENGINEERING for a Happy Holiday Season. Seated (l. to r.) C. L. Willey, Executive Secretary and Chet Tomczak, Publications Manager. Standing (l. to r.) Winifred Forsyth, Helen Shinovich, Josephine Lapointe, and Irene Todd.

The Officers and Directors of ASLE also take this opportunity to extend heartfelt Season's Greetings to all readers of LUBRICATION ENGINEERING.

As we go to press, we are saddened to learn of the death of Mr. Charles C. Blaisdell, ASLE Treasurer. After serving in many official capacities in the Society, Mr. Blaisdell was elected Treasurer in April, 1959. Prior to his election as Treasurer he had been a member and chairman of the Finance Committee for several years.

Mr. Blaisdell was employed as Sales Representative of the Penola Oil Company since 1939. For the past ten years he had been assigned to the Chicago office.

IN MEMORIAM

Theodore W. Langer, 53, for 12 years a research chemist at the Linde Division of Union Carbide, died Sunday (Nov. 1, 1959) of a heart attack in his home at 331 North Park Ave. Dr. Langer, listed in "Who's Who in Science" while in his early 20s, was chairman of the Buffalo Section of the American Society of Lubrication Engineers. He was to have been transferred Dec. 1 to the new plant of Union Carbide in Eastview. A native of New York City, he was graduated from Johns Hopkins University in 1928 with a bachelor of science degree and received his doctorate from Yale in 1931. He was employed by the Texas Co. 16 years before coming to Linde in Buffalo.

SECTION NEWS

Chicago—ASLE President, Dr. A. B. Wilder, E. I. du Pont de Nemours & Co. was guest speaker on National Officers Night, October 15. His subject was "Undeveloped Areas in Lubrication." A joint meeting of the Milwaukee and Chicago Sections was held in Cudahy, Wis., November 12. "Water Soluble Rust Preventatives" was subject of paper by Jack De Piazza, Esso Research Laboratories. . . . **Boston**—Dr. R. E. Booser, General Electric Company spoke on atomic power plant lubrication at October 19 meeting. November 16 meeting had P. Hollingsworth, Keppers Company as guest. His subject was "Gear Couplings, Their Design and Application." . . . **Hudson-Mohawk**—The first fall meeting was held on October 21 with George H. Link, Shell Oil Co. as speaker. The subject of his discussion was timely, "Automotive Lubrication." . . . **New York**—H. E. Mahncke, SKF Industries was guest speaker at November 12 meeting. The important subject of "Relubrication and Maintenance of Motor Bearings" was presented; a question period followed. . . . **Pittsburgh**—"Oil Country Goods and Services" was subject of a discussion by W. H. Ferguson, National Tube Division of U. S. Steel Corp. at October 8 meeting. A question and answer period followed. . . . **Rochester**—Ball bearings and some of the factors involved in their selection, lubrication and application was discussed by Dr. E. R. Booser, General Electric Co. at November 11 dinner meeting. . . . **Syracuse**—Story of the first successful oil well was presented in a movie entitled "The Story of Colonel Drake" at October 19 meeting. . . . **Toronto**—"Practical Aspects of Engine Lubrication" was title of discussion by J. J. Quinn, Chrysler Corp. at meeting on October 13. Toronto Section sponsors course in industrial lubrication at Ryerson Institute of Technology in 1960. . . . **Twin Cities**—Byrd Parmelee, E. I. du Pont de Nemours & Co. presented an important paper entitled "Why Do Cars That Look Alike Have Different Octane Appetites" at October 29 meeting. A joint meeting with the SAE group was held November 11. Bumper to axle lubrication was discussed.

Tests prove Air tools operate over 20 times longer

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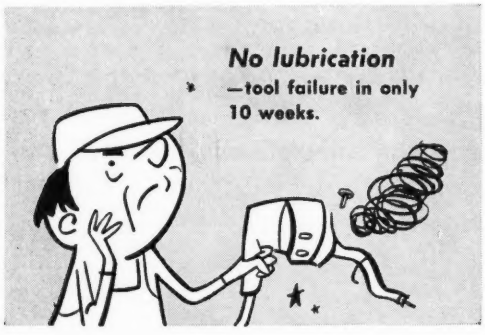

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"A Survey of Journal Bearing Literature"

by Professor Dudley D. Fuller, Columbia University.
A research project financed by the American Society of Lubrication Engineers with the cooperation of industrial sponsors.

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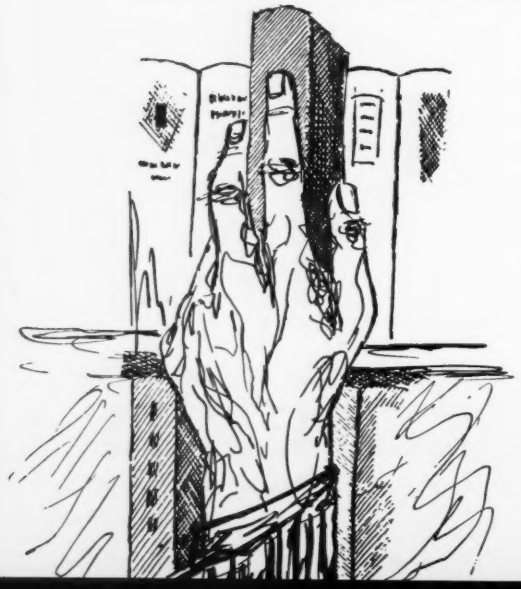

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LETTERS TO THE EDITOR

Lubrication Engineering welcomes the comments and suggestions of readers with regard to articles published in its pages or concerning topics of interest to those engaged in any phase of lubrication engineering. Letters received cannot be acknowledged, but those felt to be of interest to other readers will be published. The Society will not be responsible for the statements or opinions expressed.

Sir:

We have read with considerable interest an article (Bactericide Use Cuts Machine Shop Health Hazards) which appeared in the February 1959 issue of the American Society of Lubrication Engineers' Journal "Lubrication Engineering," in the section titled "Lubrication in the News." The Article describes a situation where adding a bactericide to a non-emulsified cutting oil was reported to have eliminated a problem of skin infection and dermatoses supposedly caused by bacteria in the cutting oil.

There is a large body of competent scientific opinion both in the U. S. and in Europe which supports the view that skin infections and dermatoses associated with non-emulsified cutting oils are very probably unrelated to bacteria in the cutting oil (see references 1-6). There is general agreement that the defatting action of oils on the skin, plugged hair follicles, scratches caused by metal chips suspended in the oil and similar conditions are factors related to skin irritations associated with cutting oil. Neither of the first two factors is related to bacteria. Further, as mentioned in several of the references cited, it is probable that any skin infections which might occur are caused by bacteria which are present on the skin at all times, rather than by bacteria carried to the skin by the cutting oil. In fact, some reports indicate that bacteria are seldom found in non-emulsified cutting oils, probably because most non-emulsified cutting oils are relatively poor media for support of bacteria growth (5-8).

It seems probable that influences other than the use of a bactericide were the cause of reduced skin infections at the plant described in the article. The use of a bactericide undoubtedly attracted attention to the skin infection problem, and probably resulted in the operators washing their hands and arms more frequently and thoroughlv, and may have led to use of protective creams, aprons or other shields, and to more frequent changing of the cutting oil (removal of suspended chips, etc.). All of these factors would tend to reduce skin infections and dermatoses, regardless of the bactericide.

The probable reason that many people attempt to relate bacteria to cutting oil dermatoses is the widely recognized problem caused by bacteria attack on soluble oil emulsions (emulsified cutting oils). It is well established that problems of odor, dark emulsion color, and emulsion separation can be caused by bacteria, and that these problems can be prevented by eliminating bacteria from the emulsion. There has been recorded in the literature much speculation as to whether bacteria in soluble oils are related to dermatoses or constitute a health hazard, for example, see 9. However, none of these articles has reported data indicating that the bacteria found in soluble oil emulsions constitute a practical hazard to the health of the workers contacting the emulsion.

In view of the above, it would appear that detailed supporting data are essential before a conclusion can be drawn that a bactericide in a non-emulsified cutting oil can significantly affect skin infections or dermatoses related to cutting oils, as claimed in the attached article. We would certainly encourage the publication of such data if it were available, since it would serve to further the industry's knowledge on an important subject. However, we are disturbed to read unsubstantiated reports on this problem, particularly when these reports occur in a section of the ASLE Journal which suggests that the Society endorses the items published.

1. Schwartz, L., "Dermatitis From Cutting Oils," Public Health Reports, U. S. Public Health Service, v 56, 1941, p 1947.
2. Campbell, P. C., "Dermatitis From Cutting Oils and Solvents," Ind. Hyg. Newsletter, v 7, n 10, 1947.
3. Shapiro, H., "Cutting Oil Dermatoses," N. Y. State Department of Labor, Discussion of Ind. Hyg. and Safety Standards, v 29, n 2, 1950, pp 5-8.
4. Pivnick, H., "Pseudomonas Rubescens, A New Species From Soluble Oil Emulsions, Journal of Bacteriology, v 70, n 1, July 1955, pp 1-6.
5. Report by Production Engineering Research Association of Great Britain, "Notes on Selection and Use of Soluble Cutting Oils," Chapter 7, pp 71-77, May 1951.
6. Report by Industrial Hygiene Foundation of America, Inc., "Good Plant Practice for Workers Using Petroleum Products," February 1959.
7. Fabian, F. W. and Pivnick, H., "Growth of Bacteria in Soluble Oil Emulsions," Applied Microbiology, v 1, n 4, July 1953.
8. Fabian, F. W. and Pivnick, H., "Coliform Bacteria in Soluble Oil Emulsions," Applied Microbiology, v 2, n 2, March 1954.
9. Wheeler, H. O. and Bennett, E. O., "Bacterial Inhibitors for Cutting Oils," Applied Microbiology, v 4, n 3, May 1956.

J. L. Murray
Esso Research & Engineering Co.
Linden, N. J.

Editors note: Articles appearing in Lubrication in the News are taken from vendors copy. ASLE will not be responsible for the validity of the statements set forth.

Sir:

We appreciate the fact that a story about *the* use of a bactericide in cutting oil appeared in the February issue of your fine publication. *The user* later sent me a copy of a letter written to you by J. L. Murray objecting to several points in the story.

We are sorry about this. We reported this case study based on facts submitted by the product user as well as from information available to our technical people.

In our work we have no intention to mislead and have all editorial material checked thoroughly.

From the facts we have on this use and the knowledge of our technical people, it is our belief that the story was not inaccurate.

Gordon Sears
Dow Chemical Co.
Midland, Mich.

plans to attend
1960 ASLE Annual Meeting
April 19, 20, 21
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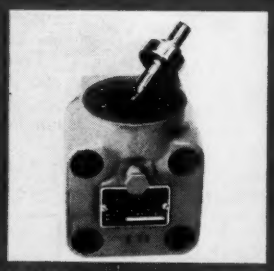
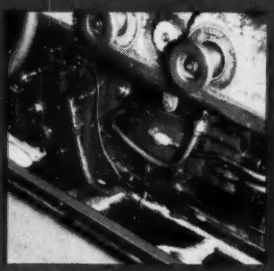


VALVES Carefully selected additives combine with high-quality oils to prevent wear, rusting and deposit formation.



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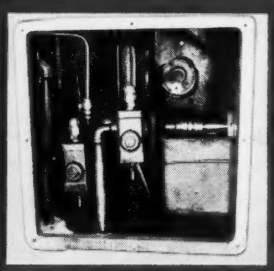

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And Atlantic Hytherm Oils also provide excellent versatility. In fact, they've been used successfully in a variety of "hot-oil" heat exchange systems with a minimum of undesirable deposits. They are highly recommended for lubricating compressor cylinders, rotary compressors, enclosed gear and chain drives, dryer roll circulating systems, machine tool drives, small steam turbines and other applications where over-all stability is highly necessary.

Your Atlantic Sales Engineer will welcome the opportunity to discuss the application of these oils to your specific requirements. In cases where detailed analysis is required, the facilities of the Product Development & Technical Services Division are at your disposal, entirely without obligation. Simply call or write to The Atlantic Refining Company, Pennypacker 5-2345, 260 S. Broad Street, Philadelphia 1, Pa.

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Lube Lines

by A. F. Brewer*

APPLIED LUBRICATION

Today's lubrication engineer is a creative as well as an investigational individual. He is equally as interested in making use of new ideas as in obtaining the new ideas in the first place. In other words, he asks himself how can each new idea be translated into plant practicability.

So we come to the theme of this discussion which is how to get research and development people to present the new idea they have uncovered in language which will make it possible for the lubrication fraternity to grasp these new ideas and put them to work.

Research is mandatory if any component of industry is to maintain its position as a partner in the study of reduced maintenance costs through the usage of more effectual methods of producing and utilizing lubricants. Modern management is fully cognizant of the need for research and the wisdom of translating the findings or theories of research into production line results. Sometimes, however, just how to develop this translation constitutes a problem. In this connection, it is very helpful if the research worker himself, or the associate who is charged with presentation of the idea assists in this effort. Thus by "coming out of the clouds," as it were, information which could well remain in the laboratory files can be more quickly put to practical use.

A good way to promote this realization of a most important fact of business life is for the researcher to ask himself—"so what!" after his data is assembled but before his report or paper is put in final form for presentation. If possible, he should try to summarize his "benefits" in a concise introduction. Possibly his charts and drawings will justify the time-honored Chinese proverb as to being worth a thousand words, but he must remember that his audience normally is composed of a wide range of minds, some keenly sympathetic with his findings, some too brutally practical, some representing a tough management which insists on "show me or else."

An introduction which refers to the prospective cash value or savings benefits would appeal to many who want to be able to see the forest without becoming blinded by the trees. Almost all managerial people just don't have the time to read or digest technical data however much they might like to. But give them a pre-digested brief of how the data could benefit reduced maintenance or more dependable production and they'll usually sell themselves on the wisdom of giving their lubrication engineer a favorable decision.

When the lubrication engineer in turn can subsequently come up with favorable cost records to justify this confidence of his management, the latter will have added respect for the value of theory and laboratory research as related to applied lubrication.

* Consultant and author "Basic Lubrication Practice."

250,000 Power Tools per year with Cities Service Pacemaker T

Porter-Cable, one of the world's largest manufacturers of portable wood-working tools, has long known the value of quality in a lubricant as well as in a power tool. Each piece of equipment made by Porter-Cable is carefully pretested before manufacture and then continually tested for years after its original appearance on the market. It is this kind of thoroughness that led to Porter-Cable's choice of Cities Service Pacemaker 300 T as the hydraulic oil to power their Fostermatic Screw Machines and Landis Grinders.

But Cities Service Pacemaker T is more than a hydraulic oil . . . it is a multi-purpose line of lubricants suited for many applications. Porter-Cable also uses Pacemaker 300 T for lubricating valves in the plant's compressors. Pacemaker T can be used to lubricate bearings, diesel engines, electric motors, generators, reduction gear drives, turbines and in circulating systems.

Pacemaker T is available in various viscosities to give you one line of quality lubricants that can save costly warehouse space by simplifying your inventory . . . cut maintenance costs and extend equipment life. These oils have high viscosity index, excellent heat resistant properties and are chemically fortified against oxidation, corrosion, rust formation and foaming.

Contact your nearest Cities Service office and an experienced Lubrication Engineer will call to make specific recommendations for your plant on the use of Pacemaker T. Or for further information, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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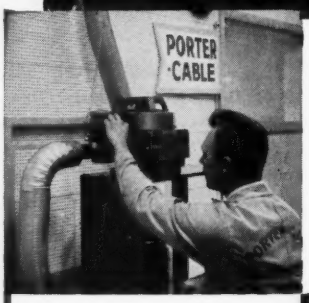

Porter-Cable Research Engineer testing engine for new lawnmower the company will produce soon. All new products undergo extensive research and testing before production.

Backbone of Production Line is Automatic Screw Machine. Pacemaker T gives outstanding performance as hydraulic medium in these machines as well as in Landis grinders and as a general lubricant!

Vol. 15, No. 11

Lubrication Engineering

our society

The proposed new Constitution for the American Society of Lubrication Engineers, which was circulated to the entire membership of ASLE, has been approved by letter ballot.

I wish to extend thanks to all members of the Society for your cooperation and response to this proposal for a change in our Society law. More than 50 per cent of the members returned their ballots regarding this change. Less than two per cent of those voting (30 members) voted against the proposed change in our Society law. Also, less than two per cent of those voting (31 members) were not tabulated in the final counting because of improper handling or ballots arriving later than the one month's voting period involved.

It is encouraging to know that so many of our members are interested in this organization and responded in such a liberal manner in the proposed change. We are indebted to each of you in this regard.

The new Constitution will enable the Society to operate in a more satisfactory manner. It is expected that all members of ASLE will be greatly benefited by these changes. As you know, the Society is operated in accordance with the wishes of its members. It is believed that the new Constitution will pave the way for the Society to grow and render better service to industry problems involved in lubrication engineering. The Constitution provides that various groups in the lubrication fields will be represented. No Society such as ours can grow and prosper if the affairs of the Society are controlled by a small segment of the field of lubrication engineering.

Again may I extend thanks to all members for their response in voting on this proposed change in our Society law.

A. B. Wilder
President, ASLE

Specification of Circulating Oil Systems

by James B. Kirschner

Wheeling Steel Corporation,
Benwood, West Virginia

Recently the author's company adopted an Engineering Standard for use in specifying circulating oil lubrication systems for company use. The Standard was developed by a committee representing the Standards, Purchasing, Research and Field Engineering Departments of the Company. It is being presented with the thought that it may be of interest to others having the problem of specifying such equipment.

The complete Engineering Standard is not presented. Sections that seem repetitious have been omitted. At intervals, comments are given concerning particular specification requirements.

AN ENGINEERING STANDARD FOR CIRCULATING OIL LUBRICATION SYSTEMS

Scope:

The purpose of this specification is to provide detailed requirements for circulating oil lubrication systems for use on industrial equipment, especially those used in the steel industry. The objective is to insure safety to operating personnel, uninterrupted production, and long life of the machine, equipment, or tool.

Requirements:

General System Requirements—These requirements apply to all circulating oil lubrication systems.

Maximum System Temperature—The system design and capacity shall be such that the maximum oil temperature in any part of the system or machine will be 140 F.

System Capacity—The minimum capacity of the system in gpm (gallons per minute) shall be the total of the sum of the oil requirements for all bearings lubricated by the system, plus one-third gpm per inch of face for all gears lubricated by the system.

System Design—The system shall be designed so as to insure the flow rate specified.

Presented before the 14th ASLE Annual Meeting in Buffalo, New York, April, 1959.

Oil Viscosity—The oil viscosity for the system shall be specified by the machine designer subject to approval of our Lubrication Department.

The General System Requirements are to assure a system that can deliver the proper amount of oil to each lubrication point. System operating temperatures above 140 F create a condition adverse to oil stability.

Detailed System Requirements—These requirements apply to components used in circulating oil lubrication systems.

Heaters—Heaters shall be furnished on all systems that supply oil to more than one machine and/or where ambient temperature of equipment may be below 40 F and/or has any pipe runs of more than 25 feet to the farthest lubrication point and/or has a reservoir capacity of 751 gallons or more. Where heaters are required, the following heater requirements shall be met as the minimum operating characteristics.

The heating coils shall be located in the oil reservoir tank and shall be capable of maintaining a minimum oil temperature of 100 F with an ambient temperature of 0 F when operating on saturated steam at ten psig.

The heating coils shall be of such design so as to be able to withstand an internal pressure of 150 psig minimum.

Automatic temperature controls of the proportional type shall be provided.

A steam pressure regulator capable of reducing 150 psig incoming steam to ten psig steam (or any intermediate pressure) in the heating coil shall be provided.

A (Y) type strainer shall be installed on the inlet side of the steam control valve and regulator.

A manually operated valve shall be located in the steam line ahead of the strainer to allow for removal of the strainer.

A Fahrenheit thermometer shall be installed in the reservoir tank. It shall be located in such a manner as to afford easy readability and shall be replaceable without causing leakage.

All steam traps shall be of the thermostatic or bucket types.

Heaters are required in most of our circulating oil systems. Winter operating conditions are such that, without heaters, oil viscosity would increase sufficiently to endanger oil flow to critical points. The strainer, automatic temperature control, thermometer, and other specified components allow positive oil temperature control.

Coolers—Cooling coils shall be furnished whenever operating conditions are such that the 140 F limit will be exceeded.

All calculations used to compute cooler capacity shall be based on an inlet water temperature of 90 F when river water is used or a temperature of 70 F when well water is used. Available water pressure shall be specified by the Lubrication Department.

The cooling capacity of the coolers shall be great enough so as to insure a maximum exit oil temperature (at cooler), of 100 F.

Automatic temperature controls of the proportional type shall be provided.

A "Y" type strainer shall be installed on the inlet side of the temperature control valve.

Direction and type of proposed cooler arrangement shall be specified by the supplier on his quotation.

The oil pressure drop across the cooler shall be a maximum of ten psi.

Indicating pressure gauges shall be installed in the oil lines at the cooler inlets and outlets.

An indicating pressure gauge shall be installed in the water line at the cooler inlet.

A Fahrenheit thermometer shall be installed in the oil line at the cooler outlet. It shall be located in such a manner as to afford easy readability and shall be replaceable without causing leakage.

High material processing temperatures frequently make oil coolers necessary. The specified coolant water inlet temperatures, while seemingly high, are from actual observed conditions. The control circuit, complete with gauges and thermometer, is required for satisfactory cooler operation.

Filters—Filters shall be supplied on all systems. All filters supplied shall meet the following minimum requirements.

All filters shall be of the full-flow type.

All filters, except magnetic and throw away cartridge types, shall be of the self-cleaning type.

All filters shall have a valved by-pass to allow for filter servicing while system is in operation.

All filters shall have indicating pressure gauges installed at the filter inlet and outlet.

Filter by-pass piping and filter differential pressure gauges reduce the chance that a critical mill process will be stopped because of a clogged oil filter.

Reservoir Tank—All reservoir tanks supplied shall meet the following minimum requirements.

Tanks will be of sufficient capacity that oil drain back will not overflow the tanks when the system is shut down.

Tank capacity, in gallons, shall be a minimum of 30 times the system requirements in gallons per minute.

Tank capacity, in gallons, for a system where lubricated parts operate in the vicinity of process coolant water shall be a minimum of 60 times the system requirements in gallons per minute.

The slope of the tank to drain shall be as large as practical but not less than one-half inch per foot.

Tank shall be equipped with a sealed access door to allow for cleaning of tank.

Surface preparations and coatings for the interior of the tank shall be specified by the Lubrication Department.

All return lines that are under pressure shall terminate below normal oil level in tank. Gravity return lines shall terminate approximately six inches above normal oil level in tank.

Because of mill air contamination, a sealed tank, complete with access door for cleaning, is a vital factor to successful operation of steel mill circulating oil systems.

Pumps—All pumps supplied shall meet the following minimum requirements.

All pumps shall be mounted at a sufficient height above the floor so as to be protected from damage when floors are swept, washed, or the equipment cleaned.

All pump name plates shall be brass and shall contain, as a minimum, the following information.

Manufacturer's name and address.
Manufacturer's identifying part number.
Manufacturer's serial number.
Pump rating.

Whenever a pump is mounted so that its name plate is not readily visible, a plate with duplicate information shall be provided where it can readily be seen. The plate shall be marked "Duplicate." The name plate shall not be removed from the pump.

All pump connections shall be made so as to provide a positive suction head.

All pumps shall be clearly marked to show direction of rotation.

All pumps shall be equipped with suction strainer of as fine a mesh as possible without causing cavitation.

Factors, such as those specified above, simplify system operation and maintenance. They are, perhaps, more essential to final system acceptance than many technical refinements.

Minimum System Requirements—In addition to the above requirements, the following shall also apply to systems with reservoir capacities as indicated.

Tank capacity to 750 gallons—Minimum System Equipment.

Strainer equipped oil filler with sealed cap.

Filter type breather, of sufficient capacity, on tank.

Protected sight glass on tank for checking oil level.

Accessibly located drain plug on tank.

Manually operated, self-cleaning type or throw-away cartridge type oil filter.

The preceding equipment is the minimum required, by these specifications, for any circulating oil system. Even in these minimum requirements, an effort is made to assure a flow of clean oil to lubrication points.

Tank capacity 751 gallons to 2,000 gallons—Minimum System Equipment.

Capped, strainer equipped oil filler.

Filter type breather on tank.

Float type oil level indicator with low level signal and delayed pump cut-off.

Accessibly located drain valve on tank, minimum connection size—two inches.

Pressure or surge tank designed to meet system capacity. The surge tank shall be located between the by-pass pressure regulator and rest of system.

Motor driven, self-cleaning type filter, with differential type relief valve for automatic by-pass complete with automatic switch and light to warn of by-pass condition.

By-Pass type pressure regulator between lubrication points and all system equipment, to insure constant lubrication pressure at all lubrication points.

Tank bottom shall be a minimum of six inches above floor level.

Pump suction shall be of the floating type.

Magnetic type filter.

Low pressure switch and signal horn to warn of low system pressure.

Tank capacity 2,001 gallons or more—Minimum System Equipment.

Capped, strainer equipped oil filler.

Filter type breather on tank.

Float type oil level indicator with low level signal and delayed pump cut-off.

Accessibly located drain valve on tank, minimum connection size—two inches.

Pressure or surge tank designed to meet system capacity. The surge tank shall be located between the by-pass pressure regulator and meter, and rest of system.

Two point temperature recorder to record inlet oil temperature and cooler outlet oil temperature in Fahrenheit.

Two motor driven, self-cleaning type filters, each designed for the capacity of the system, under continuous operating conditions, shall be provided.

Filters shall be equipped with differential type relief valve for automatic by-pass, complete with automatic switch and light to warn of by-pass condition.

Lines to the filters shall be valved so that either filter can be cleaned while system is in operation.

By-pass pressure regulator shall be provided between lubrication points and all system equipment to insure constant lubricant pressure at all lubrication points.

Low pressure switch and signal horn to warn of low system pressure.

A recording thermometer to record, in Fahrenheit the temperature of oil in the tank. The recorder element in the tank shall be replaceable without causing leakage.

Tank bottom shall be a minimum of six inches above floor level.

Pressure recorder installed between lubrication points and by-pass pressure regulator.

Recording thermometer to record, in Fahrenheit the inlet and outlet water temperatures at the cooler. The recorder elements in the inlet and outlet shall be replaceable without causing leakage.

Pump suction shall be of the floating type.

The recording instruments, lights, alarms, and switches shall be mounted on a central panel board.

The requirements for this system are essentially the same as those for a 750 gallon system. Because continuous operation of a system of this size is essential for satisfactory production rates, most components, such as filters, filter by-pass, pressure regulation, low oil level signal, etc., have been specified as automatic. Pressure and tem-

(Con't. on p. 496)

High-Temperature Friction and Wear Properties of Bonded Solid Lubricant Films Containing Lead Monoxide

by R. L. Johnson and H. E. Sliney

National Aeronautics and Space Administration, Cleveland, Ohio

Lead-monoxide-base coatings for stainless steel, which are effective dry-film lubricants at 1250 F, have been formulated. Coating thickness influences the lubricating properties of the film. A thickness of 0.001 inch on stainless steel provides lower friction, lower wear, and longer endurance life than thicker coatings. In general, conditions such as high sliding velocity, or high environmental temperature, which cause the generation of high surface temperatures, are beneficial. Improved lubrication at high surface temperature is apparently associated with the formation of soft lead-monoxide-base glazes on the wear tracks. Oxides, other than lead monoxide, in the formulations influence coating properties such as melting point, adherence to metals, or chemical stability. Small percentages of silicon dioxide (SiO_2) and magnetite (Fe_3O_4) decrease the volatility of lead monoxide (PbO) at high temperatures and inhibit the oxidation of PbO to red lead (Pb_3O_4).

Serious lubrication problems have resulted from the ever increasing temperatures at which many aircraft and missile components must operate. The use of thermally and oxidatively-stable, bonded solid lubricants appears to be one promising approach to the problem of lubricating sliding surfaces at elevated temperatures. The lubricant must be capable of reducing the friction torque required in the operation of components exposed to temperatures of 1000 F or higher and capable of preventing galling of the metal surfaces.

In a previous paper appearing in Lubrication Engineering (1), NACA data was presented which demonstrated that powdered lead monoxide (PbO) was a good lubricant at 1000 F and possibly at higher temperatures. However, at lower temperatures (700 to 900 F) PbO had poor oxidation resistance and was converted to red lead (Pb_3O_4) which is not a good lubricant. Fortunately, Pb_3O_4 will revert to PbO at temperatures of 1000 F or greater. Thermochemical and chemical kinetics data are helpful in describing the oxidation characteristics of lead oxide.

Thermochemical data from (2) are presented in Fig. 1. In the lower curve the free energy changes ($\triangle F$) involved in the formation of one mole of Pb_3O_4 by the oxidation of PbO at an oxygen partial pressure of one atmosphere is plotted as a function of temperature. The temperature at which $\triangle F = 0$ is 940 F. The negative values of $\triangle F$ below 940 F indicate that Pb_3O_4 is the more stable oxide below this temperature. Conversely, the positive values of $\triangle F$ above 940 F indicate that Pb_3O_4 will be reduced to PbO at higher temperatures. The upper curve gives the $\triangle F$ values corrected for the oxygen partial pressure in air, (0.21 atmospheres) here $\triangle F = 0$ at 850 F. Thermodynamic data, however, indicate the direction in which a reaction tends but gives no indication as to rate of reaction.

Presented before the 14th ASLE Annual Meeting in Buffalo, New York, April, 1959.

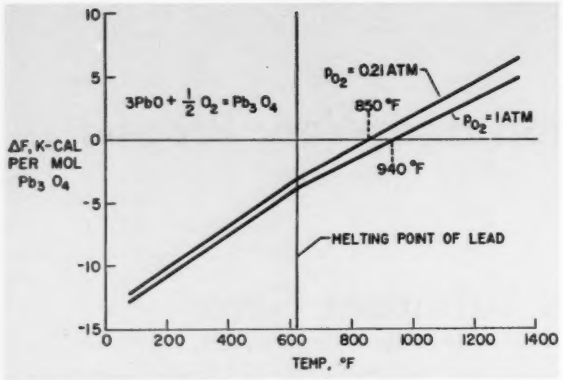

Fig. 1. Thermochemistry of PbO at various temperatures.

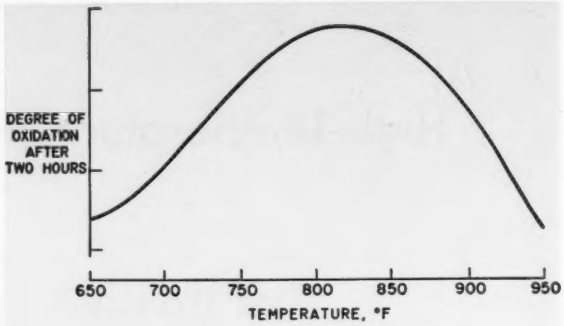

Fig. 2. Stability of PbO at various temperatures.

The degree of oxidation of PbO after two hours at various temperatures are given in (3) and are plotted in Fig. 2. The maximum degree of oxidation occurred at 820 F; about 35-per cent of the PbO was oxidized after two hours. The degree of oxidation decreases to very low values below 650 F. Beyond the maximum, the degree of oxidation extrapolates to zero at 980 F, a temperature about 15 per cent higher than predicted by thermodynamic data for the oxidation of PbO in air.

The presence of Pb_3O_4 in PbO at any time is undesirable because it reduces lubricating effectiveness. One method considered for inhibiting the oxidation of PbO is to combine it with other oxides capable of stabilizing the monoxide form of lead oxide; another is to disperse PbO particles throughout a second phase capable of physically shielding the particles from direct contact with the oxidizing atmosphere. Both methods for inhibiting PbO oxidation can be achieved by fusing it with certain other oxides in order to form ceramic compositions having a duplex structure with PbO dispersed throughout a second phase.

A study of the binary phase diagrams for PbO indicated that a duplex structure might be obtained in PbO-base ceramics containing small amounts of silica (SiO_2). Below SiO_2 content of 6.7 per cent, the phases present at equilibrium are PbO and tetralead silicate (4 PbO·SiO_2) (4). Further, the presence of small amounts of SiO_2 appreciably reduces the volatility of PbO at elevated temperatures (3). This has been confirmed in recent detailed studies of the volatility of lead-silicate melts (5). In the research reported herein, PbO-base ceramic coatings, containing small percentages of SiO_2 were studied as possible high-temperature solid-lubricant films.

The objectives of this research were to formulate PbO-base ceramics coatings, to develop methods for bonding them to metal surfaces, and to evaluate their lubricating properties. Two such coatings, one especially formulated for a martensitic stainless steel (type 440-C), the other for an austenitic stainless steel (type 304), will be described in detail. The lubricating properties of these coatings were studied at temperatures from 75 to 1250 F and at sliding velocities from six to 10,000 feet per minute.

MATERIALS AND PROCEDURE

Materials

The rider specimen for all tests were either M-1 tool steel hardened to Rockwell C-60 or cast Ni-Cr-Fe alloy (70 Ni, 15 Cr, 11 Fe, 3 Si plus small amounts of Mn and C) with an initial room-temperature hardness of Rockwell B-75 to B-80. Each rider was cylindrical (3/8-in. diam. and 3/4-in. length) with a hemispherical tip (3/16-in. rad.) ground on one end. The disk specimens (2.5 in. diam. 0.5 in. thick) to which the coatings were fused were type 440-C martensitic stainless steel or type 304 austenitic stainless steel. Before the coatings were applied, the plane surfaces of each disk were ground flat and parallel to within 0.0005 of an inch.

The coatings were prepared from reagent-grade oxide powders of about 200-mesh particle size.

Procedure

Application of coatings. Most of the coatings were applied as follows: A thin layer (about 1/16 in. thick) of dry, mixed-oxide powder was dusted onto the flat, clean surface of a friction disk. The specimen was then placed in a furnace at a sufficiently high temperature to melt the oxides and form a uniform, molten film. The disk was then removed from the furnace, placed on a water-cooled steel block, and allowed to cool in room air. Some of the mixtures contained a suspending agent (bentonite). Instead of being applied as dry powders, mixtures containing bentonite were brushed onto the metal surfaces as an aqueous suspension. The specimens were then baked at 200 F to drive off the water prior to firing. The coatings were finish ground to a thickness of 0.001 inch.

The exact times and temperatures in the furnace which resulted in satisfactory coatings varied with the powder compositions. Optimum times and temperatures will also vary with the size of the object being coated and with the geometry of the furnace. For most PbO-base coatings studied, firing temperatures from 1650 to 1800 F were satisfactory.

Cleaning—Prior to each test, both the rider and the disk specimens were subjected to the following cleaning procedure:

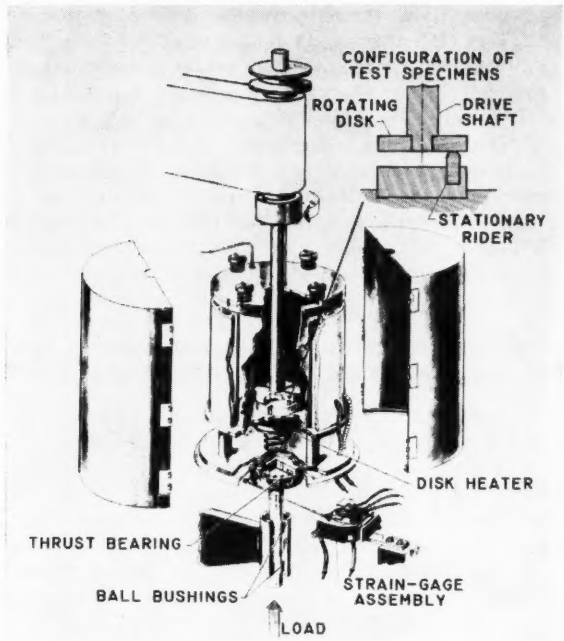

Fig. 3. Apparatus.

(1) Wash with acetone.
(2) Scrub with levigated alumina. (This step omitted in cleaning coated disks to avoid embedding alumina particles in the comparatively soft coatings.)
(3) Wash in tap water.
(4) Wash in distilled water.
(5) Scrub with acetone.
(6) Scrub with 95-per cent ethyl alcohol.
(7) Dry in room air.

Testing—The apparatus used in performing the friction and wear studies is shown in Fig. 3. A complete description of this apparatus is given in (6). Unless otherwise noted, all coatings were 0.001 inch thick. Specimens were held at test temperature for about 1/2 hour before each run. During the tests, temperature was held constant and friction was recorded continuously. Endurance life tests were run with a 2-kilogram load; all other tests were run with a 1-kilogram load. In endurance life tests, the specimens were "run-in" with incrementally increased loads at a sliding velocity of 430 feet per minute. The run-in sequence was as follows: two minutes at 200 grams, two minutes at 400 grams, two minutes at 600 grams, two minutes at 1000 grams, two minutes at 1600 grams, and finally, 2000 grams for the balance of the tests.

RESULTS AND DISCUSSION

In this investigation, methods were developed for bonding PbO-base ceramic coatings to martensitic and austenitic stainless steels by means of a fusion process similar to that employed in applying porcelain enamels to metal surfaces.

Oxides of the base metal which formed during the firing process had an important effect upon the bond strength and other properties of the coatings. Coatings, prepared by the fusion of powders consisting of 95 weight per cent PbO plus five weight per cent SiO_2 to type 440-C martensitic stainless steel were found to contain about five per cent Fe_3O_4, were well bonded to the substrate metal, and were of uniform appearance. The same powders fused to type 304 austenitic stainless steel exhibited poor bond and a mottled surface. When powders containing iron oxide (85 per cent PbO—ten per cent Fe_3O_4, and five per cent SiO_2 were fused to type 304 stainless steel, however, the resulting coating had a uniform surface appearance.

EFFECT OF COATING THICKNESS ON FRICTION AND WEAR

Fig. 4 illustrates the effect of coating thickness on friction coefficient and on rider wear at an ambient temperature of 1250 F. In these experiments, the specimens were cast Ni-Cr-Fe alloy riders sliding on type 440-C stainless steel lubricated with PbO-base coatings of various thicknesses. The results clearly demonstrate the beneficial effects of using thin coatings.

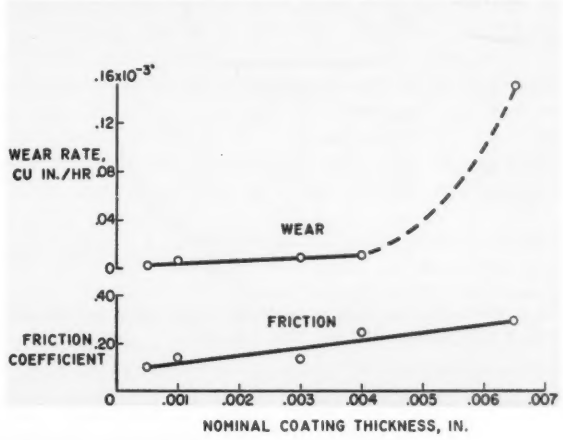

Fig. 4. Effect of coating thickness on friction properties of bonded PbO. Cast Ni-Cr-Fe Alloy Rider, 1250 F, 430 fpm, 1 kg load.

EFFECT OF TEMPERATURE ON FRICTION AND WEAR

The effect of temperature on the lubricating properties of PbO-base coatings on both type 440-C and type 304 stainless steels are shown in Fig. 5. The corresponding data for M-1 tool steel on unlubricated type 440-C stainless steel are given for purposes of comparison.

The friction and wear data for a commercial resin-bonded type of (MoS_2) molybdenum disulfide coating of 0.0003 inch thickness are given in Fig. 6. The MoS_2 film gave lower rider wear and friction coefficients than the PbO films at temperatures below 500 F. Above 600 F, however, rider wear and friction coefficients with the MoS_2 coatings increased significantly and the PbO film provided more effective lubrication. These data were obtained using a sliding

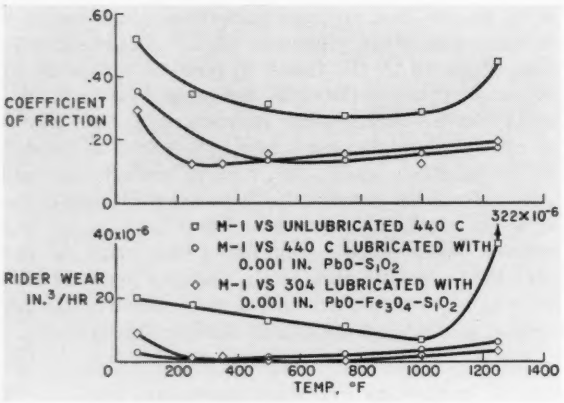

Fig. 5. Effect of temperature on lubricating properties of lead oxide-base coatings. 0.001 in. thick, 430 fpm, 1000 g load.

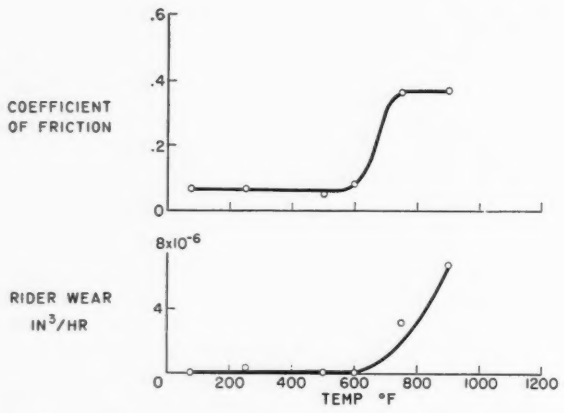

Fig. 6. Effect of temperature on lubricating properties of resin-bonded MoS_2. 0.0003 in. thick, 430 fpm, 1000 g load.

velocity of 430 feet per minute. The friction coefficients given for the PbO-base coatings apply only to this velocity because it was observed in an investigation of these coatings that the friction coefficients were sensitive to sliding velocity as well as to environmental temperature.

Soaking the specimens at temperatures of 1000 F and higher was believed to increase the amount of iron oxide in the coatings; this was deduced from a gradual darkening of the coatings. Temperatures to 1250 F for periods up to eight hours, however, had no significant effect on lubricating properties of the coatings.

EFFECT OF SLIDING VELOCITY ON FRICTION AND WEAR

In Fig. 7, the friction coefficients for cast Ni-Cr-Fe-alloy sliding against 440-C stainless steel lubricated with 0.001-inch PbO coatings are summarized over the complete range of sliding velocities (6 to 10,000 ft/min) and temperatures (75 to 1250 F) studied. The data from which these curves were plotted may be found in (6). The trends indicated on Fig. 7 illustrate that the friction coefficient decreased with either increasing sliding velocity or increased environmental temperature (conditions which cause the generation of high surface temperatures). At sliding velocities from 2400 to 10,000 feet per minute, the friction coefficients were practically constant (within the range of f = 0.05 to 0.08) at all temperatures studied.

The low friction coefficients and low rider wear, which were obtained under conditions of high surface temperature, are probably related to the formation of a glazed or glassy-surface in the zone of sliding. Sliding then takes place by the plastic or viscous shear of a soft amorphous glaze rather than by shear along crystal planes.

EFFECT OF SLIDING VELOCITY AND TEMPERATURE ON ENDURANCE LIFE

In many applications, the endurance life of bonded solid lubricants is of more practical importance than the coefficient of friction. Therefore, the endurance characteristics of the PbO coatings were determined.

The bar graphs in Fig. 8 give the endurance lives at 75, 500, 1000, and 1250 F and at sliding velocities of 350 and 2400 feet per minute. In these tests, the surfaces were run-in at gradually increased loads during the first ten minutes of each experiment. The worst endurance life performance was obtained at 75 F. As the ambient temperature was increased, the endurance life increased and approached a maximum at about 1000 F, then decreased slightly at 1250 F. The numbers of cycles to failure at a given ambient tempera-

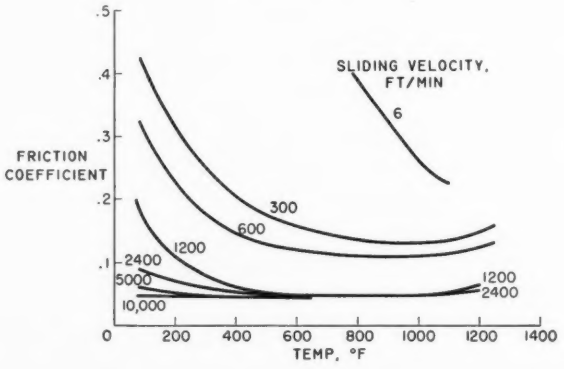

Fig. 7. Effect of sliding velocity and temperature on friction properties of bonded PbO. 0.001 in. thick, 1000 g load.

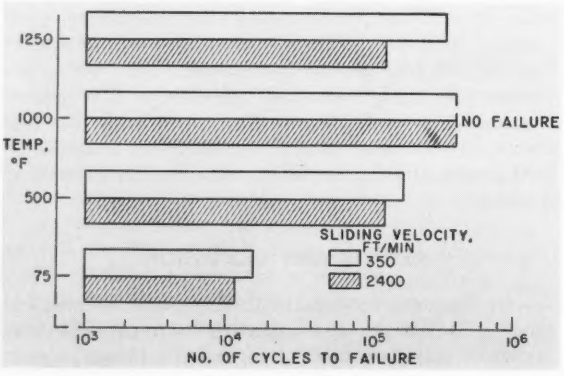

Fig. 8. Effect of sliding velocity and temperature on endurance of bonded PbO. 0.001 in. thick coatings.

ture, were of the same order of magnitude for both sliding velocities. The maximum ambient temperature at which the coatings should be used is 1250 F. This limit is necessary because the coating material begins to melt at about 1320 F.

EFFECT OF RUN-IN ON ENDURANCE LIFE

Fig. 9 illustrates the effect of run-in on the endurance life of bonded PbO coatings at 75 and 500 F and at a sliding velocity of 350 feet per minute. The endurance life values for bonded molybdenum disulfide (MoS_2) coatings, which were run for comparative purposes under identical conditions, are also shown. Run-in at gradually increased loads had no significant effect on the endurance life of the PbO coatings. Bonded MoS_2 coatings, on the other hand, appeared to be sensitive to the rate of initial loading. At 75 F run-in of MoS_2 coatings greatly improved endurance life but, at 500 F, the improvement was slight.

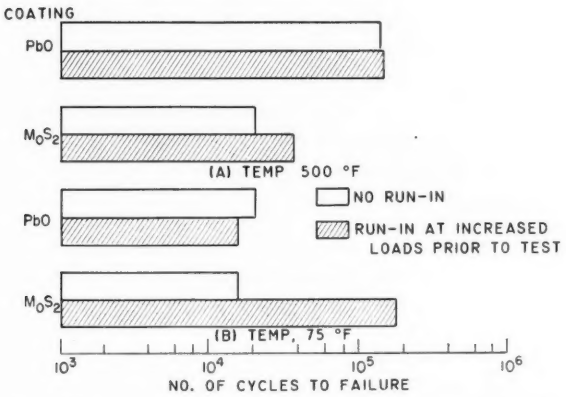

Fig. 9. Effect of run-in on endurance of fusion bonded PbO and resin-bonded MoS_2.

At 75 F the endurance life of PbO coatings was approximately equal to that of MoS_2 coatings which had not been initially run-in at light loads. At 500 F, the endurance of PbO coatings was superior regardless of the loading rate. At 1000 F, no comparisons were made because of the chemical instability of MoS_2 in air at these temperatures.

EFFECT OF VARIOUS OXIDE ADDITIONS ON THE PROPERTIES OF PbO-BASE LUBRICANT COATINGS

The data presented above have been for PbO-base coatings containing iron oxide and silica or compounds derived from them. Other oxide additions were also investigated and a number of specific effects were noted.

The fusion of pure PbO to type 440-C stainless steel produced a coating containing about ten weight per cent of magnetic iron oxide (Fe_3O_4). This oxide was formed by oxidation of the base metal during the firing process. Iron oxide imparts hardness to the coating and appears to stabilize the PbO form of lead oxide. Both α- and β-PbO were identified by x-ray diffraction studies of this coating; no other lead oxides were identified. During lubrication tests of one-hour duration, the lubricating properties were about the same as those of the silica-containing coating on type 440-C steel. However, considerable base-metal oxidation appeared to take place at the metal-ceramic-interface of the silica-free coating during tests at 1250 F. This could be a serious problem for long time applications, and indicates that one of the effects of silica is to inhibit the rate of base-metal oxidation.

The addition of SiO_2 or boric oxide (B_2O_3) to the powder batch resulted in coatings on type 440-C steel with less than about 6-per cent iron oxide in the final composition. Only α-PbO, iron oxide, and occasionally a faint quartz pattern were detected by x-ray diffraction studies of the silica containing coatings. The coatings containing B_2O_3 were amorphous to x-rays indicating a high degree of vitrification. Studies of the latter coating demonstrated that it became extremely soft at 1000 F, and was a poor lubricant at 1000 and 1250 F.

The fusion of powders containing 95 per cent PbO and five per cent V_2O_5 to type 440-C stainless steel resulted in coatings containing over 12-per cent iron oxide. The presence of V_2O_5 in the melt appears to accelerate base-metal oxidation. This agrees with reports in the literature (7) which showed that the oxidation rates of stainless steels in contact with V_2O_5 are higher than those of the same alloys heated in air alone. The bond strength of these coatings was not consistent. When no bond failures occurred, the lubricating properties were quite good from 75 to 1250 F. This coating may be of interest if the bond strength can be improved.

A modification of the PbO-SiO_2 coating applied to 440-C stainless steel was made by the addition of ten weight per cent bentonite clay to the original 95 per cent PbO, five per cent SiO_2 powder mixture. Bentonite was effective as an agent for holding PbO and SiO_2 in suspension in water. Water suspensions of the modified powder composition were sufficiently stable to permit brushing or spraying without the need for continuous stirring. The brushed coatings were baked to drive off the water and were then fired in the same manner as the other coatings.

For coatings applied in this manner, the friction coefficients were about the same as those obtained with the unmodified PbO-SiO_2 coatings of Fig. 5. Rider wear also was about the same at 500, 1000, and 1250 F, but was considerably higher than obtained with the unmodified coatings at lower temperatures. The coatings failed by brittle fracture early in the tests at 75 and 250 F. The brittleness of the coatings at low temperatures was imparted by the aluminum silicate content of the bentonite. The embrittlement problem can probably be avoided by using organic suspending agents such as gum arabic or gum tragaconth which will burn off during the firing of the coatings.

CONCLUDING REMARKS

In an investigation of methods of forming PbO-base solid-lubricant coatings, and in evaluating the friction, wear, and endurance life properties of the coatings, the following major results were obtained.

(Con't. on p. 496)

Performance of a high vacuum pump depends greatly on the quality of its sealing oil. Special oils of low vapour pressure are employed to obtain the best results in the evacuation process. However, in such service the oil is exposed to contamination from air and other vapour media that the vacuum pump has to handle, which reduce the oil's sealing and lubricating effectiveness. Removal of these contaminants through continuous conditioning of the oil not only improves its lubricating value, but also increases pumping speed and ultimate vacuum of the system.

Conditioning of Vacuum Pump Oils

by G. Topol

S. F. Bowser Company
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USE AND LIMITATIONS OF VACUUM PUMPS

Vacuum pumps are becoming increasingly important in our fast advancing technology and science. New industrial processes harness vacuum to an extent never imagined heretofore. Motivation and processing by high vacuum plays a key role in many of Science's most spectacular penetrations today. Chambers simulating high altitude conditions are widely used tools in man's conquest of space. Efficient evacuation is important for items of everyday use such as electronic tubes, TV picture tubes, and highly specialized scientific instruments. Vacuum is used in a wide range of industry and in processes as diverse as vacuum casting, freeze drying, molecular distillation and many others.

Considering the number and variety of applications of vacuum it is rather interesting that the equipment used for evacuation is similar in nearly all cases and so are problems connected with its operation (1). Rotary vacuum pumps are employed in the great majority of systems, either alone or in conjunction with diffusion pumps. While rotary vacuum pumps may differ in their design configurations, their operating principle is similar. Oil is used in them for lubrication as well as for sealing of clearances between moving and stationary parts. Effective sealing is of paramount importance and unless the oil is capable to fulfil this function resultant performance of the pump is seriously impaired. To provide a good seal against vacuum the oil must possess low vapour pressure. Special highly refined oils are therefore used to obtain the best results in evacuation. However, during operation of the vacuum pump, the oil is repeatedly being brought into intimate contact with air, or other media being withdrawn (2). Air, gases, moisture and condensable vapours are thus drawn into the oil and become dissolved, or suspended in it. This type of contamination increases the oil's vapour pressure to an ultimate point where its sealing ability is destroyed and the oil has to be replaced. Reduced vacuum pump efficiency due to oil contamination, together with shut-down time and cost of oil replacement is a serious economical factor.

INTERNAL PUMPING

Sealing oil is continually fed from the oil reservoir into the vacuum pump. Under vacuum conditions, which the oil encounters, part of its volatile contaminant is released in gaseous form. Resultant expansion, governed by the degree of vacuum, reduces useful displacement of the pump, because the pump is compelled to remove contaminant vapour in addition to the air

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or medium which is being evacuated. When the volume of gases and vapours, released from the oil becomes equal to the pump volumetric displacement, the pump "blanks off" and becomes unable to create a higher vacuum. Under such conditions the pump's capacity is fully used-up on evacuation of contaminant gas and vapour released from its sealing oil and this "internal pumping" is the prime cause of reduction in effective vacuum pump output (3). Even an extremely small amount of volatile contamination can cause serious deterioration of pumping speed and increase the ultimate pressure obtainable from the pump. In many cases a highly efficient vacuum pump performing to full satisfaction when filled with new clean oil will show signs of reduced performance only a few minutes later.

Inasmuch as reduced performance can be traced down to oil contamination which is often impossible to avoid, continuous purification of the sealing oil appears to be the most practical way to maintain the oil and related pump performance in top condition.

METHODS OF OIL PURIFICATION

Application of Heat: The oil is heated to high temperature whereby water and other volatile contaminants are vapourized and thus expelled from the oil. The high temperature involved in this method may cause oxidation and deterioration of the oil. If treated immediately before entering the pump a cooler has to be provided to reduce the oil temperature. The other disadvantage of this method is, that it does not remove air and gases actually dissolved in the oil.

Settling, Centrifuging and Filtration: Most free water can be separated by settling and centrifuging; however, due to agitation water tends to become emulsified in the oil and in this form neither settling nor centrifuging will produce complete separation and expulsion. A limited quantity of water can also be removed by an adsorbing filter; however, once water-saturated, it becomes completely ineffective as a continuing water remover. A further limitation of settling, centrifuging and filtration is, the inability to remove contaminant air, gases and liquids already dissolved in the oil.

Gas Ballast: In this method a limited quantity of air or inert gas is introduced into the pump before the end of the compression stroke. This prevents condensation of water and other vapours into the oil. This method works effectively when the amount of contamination is relatively low. Its disadvantages are, reduction of pump capacity, increase in power consumption and increase, rather than decrease, of the dissolved air and gas content of the oil.

Vacuum Purification: Volatile contaminants are removed by exposing the oil to vacuum at slightly elevated temperature. The main advantage of this method is that contaminants are removed under conditions similar to those existing in the vacuum pump. Consequently vacuum purification decontaminates the oil selectively removing the most objectionable contaminants most effectively. However, conventional vacuum purifiers are rather complex pieces of equipment, too big and vulnerable to be used with the vacuum pump.

AN EXPERIMENTAL PURIFIER FOR SEALING OILS

Preliminary experiments and practical field experience indicated that from the standpoint of vacuum pump performance vacuum purification of the sealing oil was the most effective method. Consequently an effort was made to build a simple and efficient vacuum purifier suitable for this type of service. The resulting experimental purifier was then evaluated with vacuum pumps under controlled laboratory conditions and in actual field service. The data obtained from tests illustrate the effect of oil contamination and subsequent purification, on vacuum pump performance. The design and operation of the purifier and test results will be discussed next.

OPERATING PRINCIPLE OF THE OIL PURIFIER

The experimental unit uses the well known principle of exposing the oil to vacuum at elevated temperature. This principle was combined with a rather unusual method of producing vacuum. A positive displacement pump serves double duty acting alternately as an oil circulating and vacuum generating pump (Fig. 1).

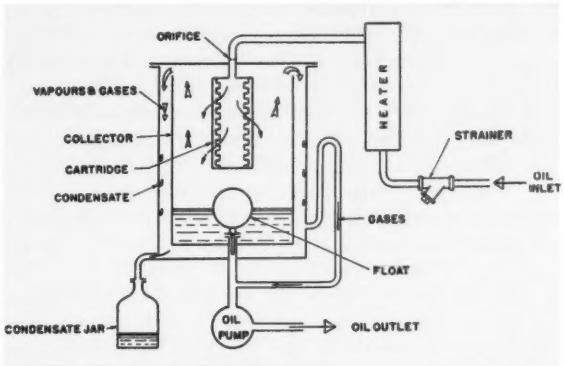

Fig. 1 Vacuum pump oil conditioner.

The oil is drawn into the vacuum chamber by vacuum maintained therein; it flows through a heater, an orifice and enters the chamber through the body of the cartridge. The structure of the cartridge distributes the oil evenly over a large area and also initiates vaporisation of volatiles and release of the air (4). On the surface of the cartridge air and vapours separate and purified oil collects at the bottom. Air, gases and vapours rise towards the top of the chamber where they reverse and travel downwards through the annular clearance, between the collector and the outer shell. The outer shell, being exposed to the air, is cooler than the oil and acts as a condenser. Vapours condense on it in the form of droplets, which slide to the bottom and finally drain into the condensate jar.

According to the position of the float valve the positive displacement pump either pumps oil from the collector or exhausts air and gases from the bottom part of the external shell. The float is provided with a flat circular poppet at its bottom. When the level of oil in the collector is high the buoyancy of the float lifts the poppet above the seat and oil floods the standpipe through which the collector communicates with the suction port of the positive displ. pump. The oil also floods part of the tubing connecting the standpipe with the bottom part of the external shell. This prevents gases from entering the suction port of the pump, therefore, the pump acts as an oil discharge pump, delivering the processed oil from the chamber back to the vacuum pump oil reservoir.

Since the pump discharges the oil at a faster rate than it is admitted into the chamber, through the orifice, the level of oil in the collector drops and the float follows the receding level until the poppet reaches the immediate vicinity of the seat. When this happens the poppet is suddenly drawn against the seat and the flow of oil is cut off. The loss of buoyancy corresponding to the seat area will cause the float valve to stay in the closed position while the pump removes the oil from the standpipe and starts drawing air and gases from the chamber through the tubing. Since the pump was previously wetted by oil which acts as a sealing medium, it can act as a vacuum pump. The time for which the pump can effectively draw gases is limited to a few seconds duration, until the sealing oil is expelled. Before this happens the oil level in the collector increases until the float lifts the poppet from the seat. At this moment the oil rushing underneath the poppet increases the float buoyancy and consequently the float valve pops suddenly into a fully open position. The oil floods the standpipe and gas tubing and the pump assumes its oil pumping duty.

These alternate pumping and evacuating cycles repeat at short intervals, and purified oil and gases are separately discharged back into the vacuum pump oil reservoir. This alternate cycle operation, rather than a simultaneous pumping of combined oil and gases, minimizes the chance mixing of oil and gases in the discharge line and the possibility of their becoming re-dissolved. After reaching the oil reservoir, bubbles of gas separate readily from the degased oil.

LABORATORY TESTS

A series of tests were performed on a 13 CFM single stage vacuum pump. Provision was made for controlling the sealing oil temperature. Such arrangement made it possible to investigate the effect of oil contamination and temperature, separately. A Pirani gauge was used in preference to the McLeod gauge because of its ability to measure the absolute pressure of both permanent gases as well as vapours. Water which appears to be the contaminant most commonly found in vacuum pump oils was used for the test. The relation between percentage of oil contamination and the ultimate pressure obtainable from the vacuum pump is plotted in a diagram, Fig. 2. It is interesting to note that even a minute quantity of moisture in the oil can seriously impair the ability of a vacuum pump to pull satisfactory vacuum.

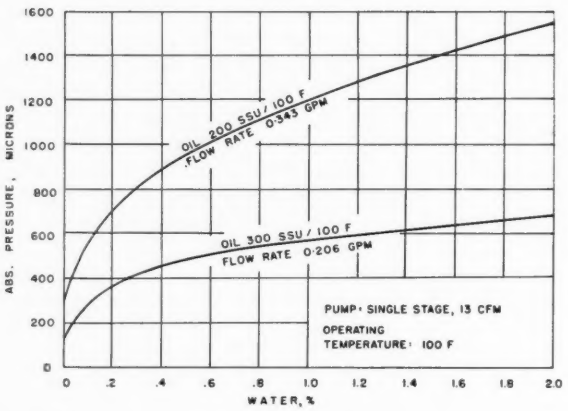

Fig. 2 Ultimate pressure vs. oil contamination.

This can be explained by the fact that water and oil are two immiscible liquids. Present in emulsified form, water does not follow Raoult's law for equilibrium vapour pressure, which is applicable only to fully miscible liquids. Thus, even a very small quantity of emulsified water can increase the equilibrium vapour pressure of oil to that of water. Theoretically any water present in the oil would increase the vapour pressure of an average sealing oil many thousand times. However, this rule applies only to equilibrium conditions which would require a considerable time to be reached. Fortunately the speed at which the vacuum pump operates does not permit full vaporisation of volatile contaminants. The oil is exposed to vacuum only for a fraction of a second before it is expelled from the pump. Since differing vacuum pumps vary in degree of wear, operating speeds, temperature, flow rate of sealing oil and other design parameters, the same type of oil and oil contamination can produce entirely different results.

In the case of water contamination the problem becomes still more complex. During contamination tests it was noticed, that the ultimate pressure tended to increase with time, though the temperature and percentage of water contamination was kept constant; the only noticeable difference being the degree of emulsification. Shearing forces acting on the sealing oil when the pump is in operation tend to split its suspended water content into myriad microscopic droplets. It would appear that highly emulsified water vaporises faster and therefore presents higher "internal pumping" load on the vacuum pump. This assumption was also supported by results of decontamination tests.

The experimental oil purifier was connected to the vacuum pump oil reservoir. It was run simultaneously with the vacuum pump whose oil was initially contaminated with two per cent of water and the ultimate pressure was plotted against time of purification (Fig. 3). During the test the appearance of the oil was inspected under a microscope. Gradual decrease of total amount of water droplets was clearly evident. Smallest drops disappeared first and consequently the emulsion became coarser, large drops becoming predominant.

Quantitative analysis of samples taken during the test showed consistently better ultimate vacuum for identical water contamination when compared with results of contamination test (Fig. 2). These observations are in agreement with the assumption that water vaporizes faster from a fine emulsion than from a coarse emulsion. The type of purifier used employs vacuum for contaminant removal and therefore removed the most objectionable small droplets first. In this respect usage of vacuum for oil purification is preferable to other methods, which operate in complete reverse, removing coarse drops first and tend to pass the more damaging fine emulsion.

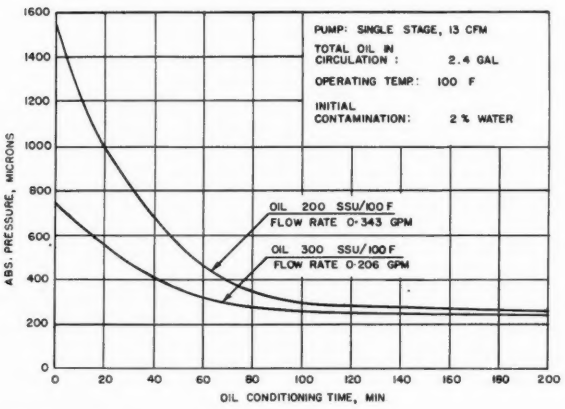

Fig. 3 Ultimate pressure vs. oil conditioning time.

FIELD TEST DATA

Previously described tests were run under controlled laboratory conditions with artificial contamination. In order to establish the type and rate of contamination build-up in actual service, oil samples were taken from vacuum pumps performing various services. In a number of cases a full charge of oil was purified and returned to service. In one case the experimental purifier was installed in the field in connection with a heavily contaminated pump.

Oil samples that were taken from operating vacuum pumps contained water distinctly detectible by cloudy appearance of the oil. Water content ranged from 0.05 per cent to more than five per cent. All oils were fully or nearly saturated with gas. Depending on the vacuum pump application several samples contained solvents and solid particles. Contaminated oils processed in the purifier and returned to service were reported fit for re-use, thereby saving the cost of a new oil batch and its attendant labour and down-time changes. In actual service test, the experimental purifier was connected to a 130 CFM single stage pump used in one phase of manufacture of selenium rectifiers. Oil contamination was badly affecting quality and quantity of the manufactured product; besides being costly as a result of the frequent oil changes. When the oil purifier was started the oil in the pump reservoir contained 1.35 per cent water and 0.36 per cent solids. After five hours of operation contamination was reduced to 0.13 per cent water and 0.058 per cent solids. This was further gradually reduced after 4 days of operation to an equilibrium value of approx. 0.1 per cent water and 0.025 per cent solids. In this application both the vacuum pump and the purifier operated eight hours every day. The pump on which the test was performed was only a part of an evacuating system consisting of three mechanical and one oil diffusion pump, yet from process record sheets it was learned that the average vacuum was increased from 12 microns to seven microns after oil purification was started.

CONCLUSION

Though the laboratory tests were limited to only one pump and one type of contamination they demonstrate the importance of oil cleanliness for the performance of a vacuum pump. They show that a quantity of only 0.1 per cent of water in oil can more than double the ultimate pressure as compared with a clean oil. They also show how the oil and vacuum pump performance can be up-graded through a simple method of continuous oil conditioning.

However, the 13 CFM pump used for tests was relatively small and the ratio of sealing oil flow to pump displacement relatively high, as compared with larger pumps used by industry. Such large units are capable of pumping to much lower pressures than those indicated in Fig. 2, yet, since the operating principle of small and large pumps is identical, little change can be expected in the basic shape of the curve; indeed only the vertical scale will be different.

Judging from oil samples taken at random from vacuum pumps on various industrial applications, water appears to be the most frequent contaminant. Effect of this contamination will be increasingly pronounced in applications calling for high degree of vacuum, also on wet evacuating services. Effect of wet oil on coarse vacuum service will be less objectionable, because even heavy contamination will not seriously affect pumping speed. Nevertheless, impaired lubricity plus attendant corrosion problems which inevitably follow use of contaminated oils in any kind of service, present a strong second argument for continuous conditioning of vacuum pump oils.

ACKNOWLEDGMENT

The writer wishes to express his appreciation of the help extended to him by the Management of the S. F. Bowser Company Limited which made this publication possible. He acknowledges the co-operation of R. Bulte with respect to equipment design and laboratory research; he extends his thanks to those Companies and their personnel who assisted in practical application and field testing of the equipment.

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SPECIFICATION OF CIRCULATING OIL SYSTEMS

(*Con't. from p. 486*)

perature indicators have been replaced by recorders.

Piping—All piping shall conform to the following limitations.

All pipes and tubing shall be of steel.

All oil line valves, etc., shall be free of zinc, lead, copper, aluminum, or other catalytic materials.

Accessibility:

Lubricating oil system equipment and piping shall be accessible and mounted in a position that will not interfere with machine adjustments or maintenance of electrical or mechanical equipment or vice versa.

Piping shall not be placed where it will interfere with the adjustment, repair, or replacement of controls and all piping connections shall be readily accessible for maintenance.

Lubricating oil system equipment shall be located so as to permit operation of manual controls without reaching past moving machine or equipment elements.

No equipment whose adjustment or replacement, other than steam lines, that would require the draining of the reservoir shall be located therein.

Graphical Diagrams:

Graphical diagrams . . . shall be supplied with all circulating oil lubrication systems furnished as meeting this specification.

For systems with reservoir capacity of 2,001 gallons or more, a copy of all diagrams for that system shall be inserted in a permanent, suitably covered diagram enclosure, attached to the equipment in such a location so as to be readily accessible, subsequent to installation.

All diagrams shall include a descriptive text explaining the function and operation of the equipment.

Either the diagram or the descriptive text shall include the following:

All lubricating equipment shall be identified. Name of component, catalog number, and manufacturer's name shall be shown.

Size of piping and tubing shall be shown.

Operating pressures.

Horsepower, rpm, and direction of rotation of each pump drive.

Each pump speed and delivery in gallons per minute. Reservoir capacity.

A complete graphical diagram is important as an aid to the operation and service of a circulating oil system. A readily available diagram simplifies training of system operators. Complete system component identification simplifies ordering of correct replacement parts. The graphical diagram is the final step in the production of a circulating oil lubrication system. ◀

HIGH-TEMPERATURE FRICTION AND WEAR PROPERTIES OF BONDED SOLID LUBRICANT FILMS CONTAINING LEAD MONOXIDE

(*Con't. from p. 491*)

1. Procedures were developed for coating type 440-C martensitic stainless steel and type 304 austenitic stainless steel with bonded films of high lead monoxide content. These films functioned as effective solid lubricants over a wide range of temperatures and sliding velocities. A downward trend in friction was obtained when either temperature or sliding velocity was increased. This trend applied up to the maximum useful temperature of 1250 F and up to the maximum velocity studied (10,000 ft/min).

2. Bonded PbO coatings are intended primarily for high-temperature applications. Relatively high friction was obtained at room temperatures, except at sliding velocities in excess of 1000 feet per minute. However, the reasonable endurance life at room temperature indicates that the coatings can be useful in many high-temperature applications requiring starting at, or cycling through room temperature. Endurance life increased with increasing temperature to a maximum at about 1000 F, then decreased somewhat at 1250 F.

3. Thin PbO coatings were more effective dry film lubricants than thick coatings. A satisfactory thickness consistent with good endurance life was 0.001 inch.

4. The detailed lubricating characteristics of two of the more promising formulations have been included in this paper. Detailed information concerning the other formulations studied may be found in (8) and (9).

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ASLE Technical Digest

Papers which, because of space limitations, cannot be published in full in Lubrication Engineering or ASLE Transactions.

"The Use of Hydraulic Oils and Fire Resistant Fluids," Kenneth W. Zintz, The Hoover Co., North Canton, Ohio.

Choice of an hydraulic fluid is predicated upon certain factors which may be classified as characteristic, operational and economic. The degree of fire resistance is probably the most pointed characteristic with respect to safety and machine performance. Obviously the fire hazard must be as low as possible especially when aluminum or zinc die casting machines are involved, also where proximity to furnaces or other machinery hot enough to ignite a flammable fluid in case of hydraulic line failure, could lead to flash fire. For this reason the temperature factor is a most important operational detail. The viscosity of the prospective fluid requires consideration because some fire resistant fluids may be so viscous at low atmospheric temperatures as to require heating especially when starting up. In effect the operating temperatures of some such fluids can be more critical than with petroleum base hydraulic oils. The former are favored however, by the fact that when exposed to excessive heat they obtain their resistance to burning by producing a blanket of gas or steam which cuts off the oxygen supply.

Sealing can present another operational problem especially with ester type fluids when subject to inadequate temperature control. Some fire resistant fluids may deteriorate sealing or packing material and leak from a joint which would normally give no trouble with mineral oils. Less seal trouble usually is encountered when operating temperatures are kept in the lower ranges. Cork can be an offender when used with water base fluids because of its tendency to absorb water. Some types can seal effectually for many months; others may be serviceable for only a few weeks.

Paint contamination of fire resistant fluids also is an operational possibility especially if the interior of reservoirs have been painted for rust prevention. Some such fluids have good paint removal ability which could be the key to subsequent contamination. Soluble or emulsion type oils are less active in this respect.

Low initial cost per gallon is always attractive, but it can become the cause of trouble in service due to possible noncompatibility of the fluid with system design and the operating conditions. Changing from one type of fluid (to take advantage of price) say, from mineral to soluble oil normally is no problem, but changing from a glycol or ester type can involve subsequent trouble unless the sytem is thoroughly cleaned.

Obviously a well planned maintenance program is necessary incident to the operation of any type of hydraulic system and the usage of any type of fluid. Proper design in the beginning, coupled with adequate means for fluid temperature control, respect for the possibility of fire hazard and provision of means for prevention, will go hand-in-hand with cleanliness in assuring optimum performance of the installation. (*Digested by A. F. Brewer*)

"Lubricants for Metal Displacement," S. J. Barber, E. F. Houghton Co., Philadelphia, Pa.

Metal shaping by displacement involves plastic deformation by press forming or drawing. Lubrication between blank and work can be a factor in obtaining satisfactory surface finish of the work material. In deep drawing or press forming plastic deformation takes place between the elastic limit and the ultimate tensile strength of the material; permanent set is attained by exceeding the elastic limit, but the ultimate tensile strength must not be exceeded otherwise rupture may occur. All this requires unit pressures far in excess of those experienced in conventional hydrodynamic lubrication; fortunately, however, the friction coefficient is of lesser importance because a controlled degree of slip is required.

As applied to the shaping of metals by displacement lubrication performs several functions. Most frequently it serves as an aid in rapid dissipation of heat. In certain instances it also may have to provide some insulation. In others it may be required to furnish a protective envelope in order to preserve the surface chemistry of the work material, or even in some cases to allow the lubricated surface to undergo a form of beneficial corrosion.

A variety of lubrication materials have been developed and used to advantage. Pigmented compounds involving whiting or calcium carbonate were among the most popular of the earlier materials because they facilitated hold-down pressure control according to the surface condition of the blank and the depth of draw. Difficulty of removal and build-up in die corners are objections, however, along with current practice of welding certain press formed shapes, fostered the trend towards use of non-pigmented materials which do not require removal prior to welding. Pre-coat application of the lubricant by spray also became a factor especially when application away from the press was practicable. Most of the materials used in this manner are completely soluble in water, consequently there is no cleaning problem. The procedure is commonly referred to as dry film lubrication, involving granular products which are used at up to 20 per cent concentration in water. Hot dipping or roller coating also is practicable, as well as spray application.

Roller coating of blanks with compounded oils also is popular especially when lower viscosity products of highly polar or extreme pressure characteristics are available. The latter is highly beneficial when stainless steels, for example, are involved. Obviously the stronger the metal the greater the load required for deformation, consequently the higher the pressure imposed upon the lubricant. Low carbon steels, on the other hand, are adequately served by highly polar fatty pastes or thin film polar liquids.

Staining of course must be considered. This can be particularly objectionable in forming copper or alloys thereof. Here neutral soaps or fatty soap pastes are most widely used, but even though the tendency towards staining may be low during processing, the residual film on drying may cause stain; hence the usual recommendation for immediate cleaning.

For drawing aluminum wax emulsions, highly polar fatty pastes or lightly fortified viscous oils are used. Although aluminum is soft and reasonably ductile, it can exert considerable abrasive effect upon die areas subject to heavy rubbing pressures. Unless the lubricant can resist this effect, localized scuffing can develop.

Lime is among the most economical of the several varieties of metal displacement lubricants currently employed. Lime coatings generally are used in the drawing of carbon steel wire, rods and bars. With the latter the lime coating is supplemented by a low viscosity compounded oil flowing over the stock as it enters the die. Rods and coarser wire sizes use granular soap mixtures. Apart from its satisfactory performance in this work, lime is cheap, simple to use and applicable to low initial cost installations.

The latest development in study of metal displacement lubrication involves active phosphate compounds in liquid or semi-fluid form, capable of reacting with ferrous surfaces to form an integral phosphate film. Active phosphate lubricants which provide chemical conversion coatings are distinctive for their adaptability to cold reduction steel tubing where two diameters must be controlled during the process.

In addition to detailed discussion of methods of procedure, the author also makes reference to such other unusual types of lubricating materials as pulverized glass for hot billet extrusion. (*Digested by A. F. Brewer*)

"Shear Stability of Lubricating Greases vs. Lubricating Performance," C. J. Boner, Battenfeld Grease & Oil Corp., Kansas City, Mo.

Shear stability can be a varied characteristic in a lubricating grease according to its degree of importance with respect to the service conditions. Evidence of desirability appears in the AAR Specification for Journal Roller Bearing Grease; the AFBMA and the United States Government Specification for general aircraft and instrument lubricating grease. There are other classes of service, however, where shear stability may be of secondary importance. Where bearing grease life may be a limiting factor, as in electric motor service, mechanical or shear stability has a decidedly favorable relationship. The extent to which shear stability is regarded as satisfactory or unsatisfactory depends upon change in penetration when the product is subjected to either 10,000 strokes in a grease worker, or to four hours in a Shell Roll Tester. Change of no more than 20 per cent of the 60 stroke worked value is considered satisfactory.

In quoting from authorities the author draws attention to the fact that the ability of a grease to remain at the point of application depends upon its original consistency and its resistance to change therefrom. Based upon a considerable amount of field testing and laboratory research the conclusion is drawn that the most shear stable grease is most resistant to oxidation. (*Digested by A. F. Brewer*)

"Fire Resistant Hydraulic Fluids in a Steel Mill," L. R. McDonald, Wheeling Steel Corp., Steubenville, Ohio.

The mechanics involved in hydraulic system design and operation as typified by steel mill service, will apply equally as well to many other similar installations. Satisfactory performance of a fluid which is truly fire resistant and of acceptable cost is the objective. It can only be attained when the chemical nature of the fluid and the mechanical details of the system are compatible with each other as well as with the operating conditions. The author points out that the essential problems which should be studied involve:

1. The possibility of rust formation.
   This can be expected with any such fluid due to the natural breathing of the tank through volume changes, with subsequent condensation of atmospheric moisture on the inner walls. The water content of the water-glycol and water-emulsion materials presents another source, especially in the vapor phase area of the tank. Addition of inhibitors reduce this possibility of rust formation and insure better protection of pump mechanisms and strainers against premature wear and rust flake accumulations.
2. Pump capacity with respect to pressure and volume.
   The pumping unit must be able to take in the required volume of fluid and boost it to the required operating pressure at the required gpm displacement. There must be the least possibility of pump cavitation,—this requires strainer mesh capacity of proper size with respect to the type of fluid. A 100 mesh suction strainer suitable for 150 ssu petroleum hydraulic oil is not adaptable to a water-oil emulsion fluid,—here a 60 mesh strainer is suggested.
3. Directional valve clearance with respect to sticking.
   Contaminants in the fluid are a common cause of valve sticking, along with possibility of insufficient clearance. Interesting data indicates that valve body temperature also must be considered as related to clearance,—slight increase in fit solved the problem.
4. Operating temperatures.
   Recommended operating temperatures are in the range of 120 F. with a maximum of 150 F. Higher temperatures can promote water evaporation. Some inhibitors also are affected by temperature extremes—hence the advisability of checking for inhibitor loss and water content of water-base fluids. Obviously the importance of maintaining the fluid up to standard and controlling the operating temperature cannot be overemphasized.
5. Corrosive tendency of fluids.
   The water-glycol fluids are corrosive to zinc and cadmium, therefore care should be taken to prevent usage of these elements in the form of galvanized piping, strainers, gages, etc.
6. Water separation.
   When this occurs from water-glycol and water-oil emulsions, the snuffer effect of water and consequently the fire resistance is reduced. Water separation is a natural tendency with some of these fluids; it can be reduced by thorough agitation, either by pump displacement (when this is high with respect to reservoir capacity) or by installing some form of mechanical agitation.

Regardless of whether the fluid is of the water-glycol, water-oil emulsion or synthetic type, some limitations must be expected. Some of these have been determined by the manufacturers, but as the author has emphasized, much additional knowledge has been gained through field experience. (*Digested by A. F. Brewer*)

"Lubrication Problems in the Cement Industry," E. F. Harchelroad, Universal Atlas Cement Div., U. S. Steel, Pittsburgh, Pa.

The manufacture of cement involves a process of progressive reduction in size of the raw materials,—limestone, granulated blast furnace slag, pure silica sand, and blast furnace flue dust,—incident to milling, blending and burning in order to obtain a closely controlled combination of lime, silica, alumina and iron oxide of an ultimate fineness comparable with flour. Since the procedure involves considerable dust, closed circuit operation prevails in order to reduce the amount of dust in the surrounding atmosphere, otherwise lubrication, not to mention welfare of personnel, could be adversely affected. Modern procedure also provides suitable dust collecting facilities, which when effectual materially reduce the possibility of dust contamination of lubricants.

Even so the presence of abrasive dust still must be considered as a major problem in cement plant lubrication, along

with those secondary causes of trouble such as wide or excessive temperature ranges, shock loads and continuous operation. The modern cement plant is designed and built to provide for these contingencies. The operating mechanisms are planned with adequate factors of safety to take care of the temperature conditions and the probable loads; seals are studied for their effectiveness in keeping out minute dust particles; and maintenance procedures are arranged with due regard for the dust-content of the air and protection of exposed machine parts from settlement thereon.

With the commendable trend towards adequate closure of gear drives and sealing of bearings the practicability of centralized lubrication has been appreciated. Continuous and effective oil filtration is an added precaution which will contribute to reduction in bearing and gear tooth wear. Periodic inspection of seals (with replacement of worn elements) also will lessen the possibility of dust contamination of the lubricants.

The author reports on specific study of a variety of lubrication procedures in line with the above, taking into consideration machine design, the prevailing temperatures and the load conditions. Overhead traveling cranes handling cement clinker, and rotary clinker kilns were typical of the service. Manually operated centralized lubrication systems contributed to low maintenance cost and decrease in time loss. Extension of the studies to new plant machinery with consideration of a variety of procedures to develop workable lubrication schedules and a cooperative personnel, resulted in the ultimate installation of automatic centralized lubrication. At a cost of less than one per cent of the new plant, savings on machine maintenance, repair and operation, along with reduced lubricant consumption indicate that the system will pay for itself by the end of three years. The number of grades of lubricants also were reduced by automatic centralized lubrication only one grade of grease and oil respectively being required.

An important finding with respect to temperature was observed in that controlled rate of lubricant feed solved the problem of ambient heat by assuring against under and over-lubrication. Possible hardening of lubricant on long conveyor runs was overcome by increasing the frequency of application with decrease in the amount discharged. Overall, the installation of automatic centralized lubrication can contribute materially in protecting cement mill machinery against the abrasive effect of mill dust by eliminating lubricant contamination; also serving as a potential bearing flushing aid by regulation of the lubricant feed. (*Digested by A. F. Brewer*)

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Lubrication Abstracts

Edited by W. E. Campbell

Selected literature compiled by members of the Technical Committees and Industry Councils of the Society.

"Halogen-containing Gases as Boundary Lubricants for Corrosion-resistant Alloys at 1200F," D. H. Buckley and R. L. Johnson (Lewis Research Center, Cleveland, Ohio). *Nat'l. Aeronaut. Space Admin. Memo* 2-25-59E, 27 pp 1959; Ind. Eng. Chem. v 51, n 5, 1959, pp 699-700.

Friction and wear studies made with a 3/16-inch radius hemispheric rider on a flat 2.5-inch rotating disk show that in atms. of halogen substituted CH_4, solid-lubricant films are formed which have coeffs. of friction on metals down to 0.05 at 75-1200F. The rider load is 1200 g with a sliding velocity of 120 feet per minute. At least two halogen atoms per mol of gas are necessary to obtain the effect observed, and, owing to the highly corrosive atm, only corrosion-resistant alloys such as Stellite, Hastalloy, and Ni-base alloys can be used. SF_6 catalyzes the surface reaction. Optimum conditions for gaseous lubrication are highly selective. The most effective combinations of gas and alloy vary with the temperature. In general, Br-substituted gases are effective lubricants for Ni-base alloys, while Cl-substituted gases are especially effective on Co-base alloys. (*Chemical Abstracts.*)

"Proper Selection and Installation of Diesel Lubricating Oil Pumps," A. Wagner (Viking Pump Co.), *Diesel Progress*, v 24, n 10, 1958, pp 34-35.

The important factors to be considered in the selection and installation of diesel engine circulating oil pumps are listed. An example is presented, including a schematic diagram of the lubricating oil system, of the installation of a straight line pump for a 3500 kw engine in a municipal power plant. The details of the installation of the pump are given. (*Abstracted by D. W. Sawyer*)

"Lubrication Problems Arising from Railway Traction Modernization," G. A. Dickins and W. B. Broadbent (Mobil Oil Ltd.), *J. Inst. Petroleum*, v 44, n 415, 1958, pp 183-197, discussion, pp 197-206.

Diesel traction, in the United Kingdom, is subdivided into three categories, namely, diesel shunters, railcars, and mainline locomotives, and in each of these categories different lubrication requirements arise. Details are provided showing the types of units in these categories and their probable lubrication requirements, including the transmissions employed. In addition, the different types of electric traction and their lubrication needs are also discussed. For diesel crankcase lubrication, the principal work to date has been confined to determining the required quality level for particular applications, such as mainline, shunters, and railcars. Selection can be made from the already adequate range of quality levels of lubricants, such as Regular, MIL-L-2104-A, and Supplement I. Certain requirements have also arisen as the result of the use of hydraulic transmissions. In the traction motor field, greases must be capable of dealing with the demands of increasing high d_mn value bearings. The indications are that recent advances in the use of water insoluble fillers, principally lithium to date, fulfill this requirement. More experience in this field is needed, however, to relate performance with composition. (*Abstracted by D. W. Sawyer*)

"Application of Radioactive Tracers to Study Wear of Piston Rings," J. Thiery, *Rev. Inst. franc Petrole*, v 13, n 7-8, 1958, pp 1197-1216. In French.

The advantages of radioactive tracer methods using a Potter AV1 diesel engine over previous chemical and physical methods in the study of piston ring wear are given. Two techniques are used in the study. In the first technique the whole of the sump oil is circulated through an external chamber, with the radiation detector located near by. In the second technique, 60 per cent of the oil falling from the cylinder is collected in gutters installed immediately below the piston skirt. The oil is pumped away from the gutter at such a rate that the gutters neither overflow or run dry. This oil is passed through a coil near a radiation detector and collected in a graduated cylinder, and a corresponding amount of new oil added to the engine. The methods used in interpreting the results using the two techniques are given. (*Abstracted by D. W. Sawyer*)

"Thermal Desorption of a Boundary Lubricant," by E. P. Kingsbury (Massachusetts Inst. of Technol., Cambridge, Mass.), *J. Appl. Phys.* v 29, n 6, 1958, pp 888-91.

A logarithmic expression relating the sliding velocity of an asperity of one surface with the friction coeff. is derived in the form $Y = AX - E/RT$. E is the heat of absorption of the lubricant on the surface on which the asperity slides and A is a const.; A is not assigned any phys. significance. For mild steel sliding on mild steel with n-$C_{16}H_{34}$ as the lubricant, the values for A and E are 1.76 and 11, kcal/mole, resp., at 25F, and 1.62 and 11.8, resp., at 100F; with n-$C_{18}H_{38}$ as the lubricant the values are 2.12 and 13, resp., at 100F. A temp. increase from 25 to 100F results in an increase in the loss of mass by a factor of 120, even though the rubbing interface is completely submerged in the lubricant. The temp. and velocity effects may be due to quasi-hydrodynamic lifting by small pockets of bulk lubricant trapped between the sliding surfaces. *Chemical Abstracts, v 53, 8766 i.*)

"The Interactions of Wear Debris with Fatty Additives in Lubrication," by Y. Tamai (University of Tokyo, Japan), *Wear*, v 2, n 3, 1959, pp 228-36.

The coefficient of friction and contact resistance between steel reciprocating on steel are measured in a pendulum apparatus. Lubricants consisting of fatty acids or alcohol in highly refined mineral oil are applied to metals which are initially smooth or rough. With the smooth surfaces, friction is low and constant; however, with initially rough surfaces, the friction is high and with continued sliding reduces to the value of the smooth surfaces. Contact resistance of initially rough surfaces lubricated with a fatty acid solution is 0.2 ohm at the beginning of sliding, reducing to lower values with continued sliding. In another experiment the author finds that the surrounding atmosphere changes the coefficient of friction. The lubricating ability of the fatty acid solution increases with decreased oxygen content of the atmosphere. These results are explained by the abrasive action and electrical resist-

ance of worn iron oxide debris in the contact area. (*Abstracted by Douglas Godfrey*)

"Harmful Effects of Electrostatic Charges on Machinery and Lubricating Oils," by T. Salomon (Inst. Francois du Petrol), *J. Inst. Petrol*, v 45, n 423, 1959, pp 47-79.

Abnormal service behavior of some turbine oils, ascribed to electrostatic charges created during operation, suggested a survey of operation incidents, published at various times but not satisfactorily explained, and also of known anomalies in the field of lubrication. It is concluded that electrostatic charges can be produced within lubricated equipment, and that such charges play a significant part in the lubrication process, particularly in the formation of oil films and in pitting wear. A new explanation of wear mechanism, based on a shock wave effect, is proposed. In one case at least, very rapid charges and discharges (500 per min.) were found. The discharge spark causes a very localized (submicroscopic) temp. rise and melting of the metal at the spark site. The insulating power of the oil is not affected, but oil deterioration may occur in the presence of such discharges, probably because of dehydrogenation. In the case of impulse breakdown, solid impurities in the oil have no effect. The differences of sliding friction and friction in rotating shafts are discussed. The usual interpretation of the elec. resistance of an oil film as a means of measuring the thickness of such films does not apply to thin oil films; in a zone with a thickness of micron magnitude the oil film can behave either as a perfect insulator or as a metallic conductor, depending on conditions. The effect of voltage on oil-film cond. is discussed; the effect of pressure has not yet been studied. 103 references. (*Chemical Abstracts, v 53, 9633 i.*)

"A Proposed Mechanism for Ice Friction," by C. D. Niven (Natl. Research Council, Ottawa), *Can. J. Phys.*, v 37, n 3, 1959, pp 247-255.

The collapsible structure of ice is stressed. The adhesion bond is visualized as being assocd. with a readjustment of a partially collapsed or distorted mol. structure when cooling sets in after plastic flow has occurred in the asperity. With this general idea in view, the friction mechanism on ice is compared in detail with that on a noncollapsible material, and explanations for observations are suggested. (*Chemical Abstracts, v 53, 8753 i.*)

"Friction and Surface Properties of Solids," by F. P. Bowden (Univ. of Cambridge, England), Rev. met., v 55, 1958, pp 1126-32.

The coeff. of friction was measured of steel on Cu and steel on Bi at speeds up to 700 m./sec. The disintegration of the surfaces is shown in optical micrographs of the surfaces. The high resolution of the electron microscope and detection of lattice defects is demonstrated by photographs of Pt-phthalocyanine crystals. (*Chemical Abstracts, v 53, 8752 i.*)

"Molybdenum Sulfide as a Lubricant for the Cold Rolling of Pipe," by I. M. Pavlov, Yu. F. Shevakin, Yu. S. Seidaliev. (Steel Inst., Moscow), Izvest. Ysshikh Ucheb. Zavedenii, Chernaya Met. No. 7, 1958, pp 191-3.

A coating of MoS_2 applied to the mandrel surface, combined with the use of a conventional lubricant, lowers the coeff. of friction, reduces the pressure of the rolled metal on the roll by ten-20 per cent, and reduces the build-up of rolled metal on the mandrel surface, so that the mandrel life is increased two-three times. The surface quality of the rolled pipe is greatly improved. Since MoS_2 is especially effective at higher pressure between rolls and metal, its greatest use is in the rolling of very thin walled pipe and in deep drawing. (*Chemical Abstracts, v 53, 9633-34-i.*)

"The Nature of Polished Metal Surfaces," L. E. Samuels (Defense Standards Laboratories, Sydney) *Australian J. Sci.*, v 21, 1959, pp 163-170.

A review of evidence against the Beilby layer and in favor of the view that metallographic polishing occurs primarily by cutting. (*Chemical Abstracts*)

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Patent Abstracts

Compiled by Ann Burchick
Aluminum Co. of America

Rust Preventive Composition, Patent #2,893,880 (E. A. Dieman and A. T. Swanson, assignors to Standard Oil Co.) A rust preventive composition consisting essentially of from about two per cent to about 30 per cent of a normal wax selected from the class consisting of sperm wax, hydrogenated sperm wax and mixtures thereof, from about 0.5 per cent to about 10 per cent of a surfactant selected from the class consisting of an alkaline earth soap of a preferentially oil-soluble petroleum sulfonic acid and a fatty acid ester of an anhydroalkitol, and from about 60 per cent to about 97.5 per cent of a hydrocarbon normally liquid diluent.

Impregnating Composition, Patent #2,893,881 (S. S. Sakornbut, assignor to Monsanto Chemical Co.) Preserving, water-repellent and fire-retardant composition for cellulosic compositions consisting essentially of a solvent oil boiling between 110 C. and 220 C., from three to eight per cent by weight of a normally solid chlorinated phenol, from eight to 20 per cent of a normally solid chlorinated hydrocarbon containing at least 40 per cent chlorine, from three to ten per cent of a hydrocarbon triester of phosphoric acid and from 0.1 to two per cent of petroleum wax, the balance of said solution being the said solvent oil, all said percentages being based on the weight of the resulting solution, said solvent oil being present as the principal component.

Defoamer Materials, Patent #2,893,883 (John T. Stephan) A defoamer composition for abatement of foam in an aqueous adhesive solution, said composition comprising a tri-alkoxy-phosphate having only one ether-oxygen linkage and at least six carbon atoms in each side chain, said tri-alkoxy-phosphate being dissolved in a water insoluble, substantially non-volatile hydrocarbon oil solvent therefor.

Lubricant Composition Having Non-Rusting and Detergency Properties, Patent #2,893,959 (E. K. Fields, assignor to Standard Oil Co.) A lubricant composition comprising a major proportion of an oleaginous lubricating vehicle and from about 0.5 per cent to about 20 per cent of an oil-soluble alkaline earth-containing neutralized acidic mixture consisting of from about 80 per cent to about 90 per cent of a hydrolyzed reaction product of a phosphorus sulfide and a normally liquid hydrocarbon, other than a medial olefin, and from about ten per cent to about 20 per cent of a hydrolyzed reaction product of a phosphorus sulfide and a medial olefin.

Synthetic Lubricant, Patent #2,894,909 (C. E. Saunders, assignor to United States of America as represented by the Secretary of the Navy) A water soluble lubricating composition comprising a water soluble polymerized alkylene oxide oil consisting of ethylene oxide and propylene oxide, and substantially two per cent by weight of ammonium linoleate.

Water-In-Oil Emulsion Lubricants, Patent #2,894,910 (C. E. Francis and N. Bulman, assignors to Shell Development Co.) A lubricant and hydraulic fluid consisting essentially of a water-in-oil emulsion in which the water phase constitutes from about 30 to about 40 per cent of the emulsion and the oil phase constitutes from about 70 per cent to about 60 per cent of the emulsion, said emulsion containing from about one to about 10 per cent by weight of hydrolyzed copolymer of a hydrocarbon α-olefin containing from ten to 40 carbon atoms and a vinyl ester of a lower fatty acid having up to five carbon atoms in the mol ratio of from 1/1 to 1/5, respectively and having a molecular weight of from 4,000 to 50,000 and from about 0.01 per cent to about 10 per cent of an oil soluble polyvalent metal C_{8-18} alkyl phenate of the metal of group II of the periodic table having an atomic number of from 12 to 56.

Fire-Resistant Hydraulic Fluid, Patent #2,894,911 (D. H. Moreton, assignor to Douglas Aircraft Co., Inc.) The composition consisting essentially of a monoalkyl diaryl phosphate in which the aryl groups are members of the group consisting of phenyl, cresyl and xylyl radicals and the monoalkyl group is a saturated alkyl radical having from four to ten carbon atoms, and from 0.2 to ten per cent of poly alkyl methacrylate compatible therewith and effective to increase the viscosity index to above 100 and increase the viscosity at elevated temperature of said phosphate in which the alkyl radical is saturated and has from two to 12 carbon atoms.

Antifoam Emulsion, Patent #2,894,913 (R. E. Sullivan and W. T. Gregory, assignors to Dow Corning Corp.) An oil-in-water type emulsion consisting essentially of (1) from 0.5 to 50 per cent by weight based on the weight of the emulsion of a benzene-soluble methylpolysiloxane of at least 50 cps viscosity at 25C containing from two to ten per cent by weight of a filler selected from the group consisting of silica and carbon black and having a particle size no greater than two microns, (2) water and (3) from .03 to 6.5 per cent by weight based on the weight of the water of methylcellulose having a viscosity of at least 400 cps at 25C as measured in a two per cent by weight solution in water.

Ester-Type Wax Oxidate of Macrocrystalline Wax and Process for Producing Same, Patent #2,894,970 (J. K. McKinley, R. F. Nelson and G. S. Bright, assignors to The Texas Co.) A process for producing a wax oxidate characterized by a neut. number of 70-100, a sap. number above 170, a sap. number to neut. number ratio of between 0.25 and 0.5, and an unsaponifiable content less than about 40 per cent which comprises reacting, for about one to ten hours, a deoiled macrocrystalline paraffin wax of 20 to 33 carbon atoms, said wax containing less than five per cent oil and isolated from a distillate lubricating oil, with air at an air velocity of 1.5 to six feet per second and at an air rate in the range of four to 38 cubic feet per hour per pound of wax, at a temperature between 300 and 350F, and at a pressure less than 25 psia.

Method for Determining the Stability of Fluorocarbon Oils, Patent #2,895,806 (Z. D. Sheldon and H. M. Haendler, assignors to the United States of America as represented by the United States Atomic Energy Commission) The method of determining the stability of a fluorocarbon oil to uranium hexafluoride which comprises treating a sample of the oil by weighing a sample of the oil, evacuating a reaction zone containing said oil sample, evacuating a container space of predetermined volume, causing the vapor

of uranium hexafluoride to flow into said container space until a predetermined pressure is attained, causing the vapor so collected to flow into the reaction zone and to condense in said zone, causing the uranium hexafluoride to react with said oil sample, and titrating the amount of uranium tetrafluoride produced by means including a standard dichromate solution.

Production of Carbon Black Oil, Patent #2,895,895 (G. F. DeRidder and W. P. Bryan, assignors to Shell Development Co.) A process for the production of a highly aromatic base oil suitable for carbon black manufacture comprising preparing a feed mixture containing substantial proportions of a catalytically cracked gas oil and a straight run aromatic extract, each of said components having at least 30 per cent by weight of aromatic hydrocarbons and with the weight ratio of the two components of the mixture being between 70-30 and 30-70 and with neither of said components having been subjected before preparation of the feed mixture to either a separate hydrogenation or a separate non-catalytic, thermal cracking, subjecting the mixture to a severe thermal cracking operation for a period of time less than 30 minutes, and separating the lighter material in a substantially atmospheric pressure separation from the thermally cracked mixture to obtain a highly aromatic residue suitable for carbon black manufacture and having overall carbon black base oil characteristics superior to that obtainable by the thermal cracking of either of the components separately.

Production of Lubricating Oil Components of High Viscosity Index, Patent #2,895,903 (R. W. B. Johnston, assignor to Shell Development Co.) A process for the production of a mineral lubricating oil from an asphaltic reduced crude which comprises: (1) subjecting the reduced crude to catalytic cracking in a disperse phase cracking zone with a silica-alumina gel cracking catalyst containing 10-15 per cent alumina and having a surface area of about 76 square meters per gram at about 950F and about 37 per cent conversion level to obtain a cracked product containing a substantial proportion of naphthenic hydrocarbons, (2) separating catalyst and formed carbonaceous deposits thereon from a high boiling 765F + distillate fraction, and (3) extracting said distillate fraction with a selective solvent for aromatic hydrocarbons and producing a highly saturated raffinate fraction of high viscosity index and lubricating oil viscosity.

Extreme Pressure Lubricant, Patent #2,895,912 (C. M. Peck, assignor to Gulf Oil Corp.) A lubricating grease comprising a major proportion of a mineral lubricating oil thickened to a grease consistency and having incorporated therein from about two to ten per cent total weight of a combination of sublimed blue lead and sulfurized sperm oil in a weight ratio to each other of from about 1:3 to 1:5.

Magnesium Containing Organic Compositions and Method of Preparing the Same, Patent #2,895,913 (R. L. Carlyle and E. F. Morris, assignors to Continental Oil Co.) The process of preparing a stable dispersion of a basic magnesium containing compound in lubricating oil compositions which comprises: (a) Reacting magnesium with an excess of an alkanol containing less than six carbon atoms forming an alkanol insoluble magnesium alkoxide; (b) forming an alkanol soluble magnesium alkoxide-carbon dioxide complex by passing carbon dioxide through the magnesium alkoxide-alkanol mixture until the same is acid to alphanaphthol benzein indicator; (c) adding said complex to a lubricating oil containing an oil soluble dispersing agent in an amount that is sufficient to give a magnesium content of the resulting mixture that is 50 to 500 per cent greater than that produced by the presence of chemically combined magnesium in the oil soluble dispersing agent alone a quantity of water that varies from 15 to 45 parts per 100 parts of said complex whereby a homogeneous system is formed, and (d) condensing from said homogeneous system an oil insoluble magnesium compound in particles the diameter of which are less than .25 micron by heating said system whereby said alkanol is removed and said complex is decomposed.

Polymeric Pour Point Depressant Compositions, Patent #2,895,915 (W. A. Hewett, R. C. Jones and L. E. Lorensen, assignors to Shell Development Co.) A lubricating composition consisting essentially of mineral oil and 0.1-2.5 per cent by weight, sufficient to reduce the pour point thereof, of a substantially linear alpha-olefin polymer having an average molecular weight between about 100,000 and about 1,000,000 and having alkyl radicals dependent from substantially each alternate carbon atom in the linear polymer chain, said alkyl radicals having an average of 12 carbon atoms each.

Process for Oxidizing Petroleum Oil and Products Thereof, Patent #2,895,978 (J. W. Brooks, assignor to Socony Mobil Oil Co., Inc.) A process for preparing a metal-containing oxidized oil product which comprises (1) forming a mixture comprising (a) a petroleum oil having a molecular weight of from about 300 to about 1000 and (b) from about two per cent to about 25 per cent, based on the weight of said oil, of a hydroxide of a metal of group II of the periodic table of the elements, (2) contacting said mixture with an oxidizing gas at a temperature of from about 250F to about 600F, to effect oxidation of said oil and reaction of said metal hydroxide with the oxidized oil, (3) continuing said oxidation for a time sufficient to effect the reaction of at least about five per cent, but not more than about 55 per cent, of said metal hydroxide and (4) subjecting the resulting reaction mixture to filtration to separate the metal-containing oxidized oil product.

Removal of Metallic Contaminants from Hydrocarbon Oils with a Foaming Agent, Patent #2,897,144 (H. Bieber and I. A. Eldib, assignors to Esso Research & Engineering Co.) An improved process for removing surface active constituents from a hydrocarbon oil which comprises foaming a portion of said oil with a nonreactive gas and separately recovering foam containing surface active compounds and oil substantially reduced in surface active constituents.

Lubricant Compositions Containing Thiopyrones, Patent #2,897,153 (C. S. Scanley and E. K. Fields, assignors to Standard Oil Co.) A lubricant composition which comprises a major proportion of a hydrocarbon lubricating oil base and an oil soluble 2,6-polythio-1,4-thiopyrone which contains at least one alkyl hydrocarbon group in the two, six positions imparting oil solubility thereto in an amount at least sufficient to impart protection against oxidative deterioration of the hydrocarbon base oil.

Method of Reducing Corrosiveness of Lubricating Oils by Hydrogenation, Patent #2,898,286 (M. P. Kleinholz, assignor to Sinclair Refining Co.) A method for the manufacture of non-additive aircraft piston engine lubricating oil of low corrosiveness when tested by the MacCoull-Ryder oxidation corrosion test which comprises reacting a mineral lubricating oil and hydrogen while in contact with a cobalt molybdate supported on alumina catalyst at a temperature of about 500 to 550F, a pressure of about 400 to 600 psig and a weight hourly space velocity of about three to seven.

High Temperature Water Resistant Lubricating Greases, Patent #2,898,295 (J. C. MacKenzie, assignor to Godfrey L. Cabot, Inc.) A grease composition stable at high temperatures even in the presence of water consisting essentially of a lubricating oil, a finely-divided inorganic thickening agent chosen from the group consisting of metal oxides, metalloid oxides, bentonitic clays and attapulgite clays, the amount of said thickening agent being sufficient to impart a grease-

like consistency to the composition, and about five per cent to 40 per cent by weight of said thickening agent of a polyamine.

Process for Forming a Grease Containing Metal Salt of Mono and Dicarboxylic Acids, Patent #2,898,296 (W. C. Pattenden, L. W. Sproule and J. H. Norton, assignors to Esso Research & Engineering Co.) A method of preparing a lubricating grease composition comprising a major proportion of a lubricating oil and a thickening amount of a thickener comprising about 20 to 80 wt per cent of a metal soap of a fatty acid and about 80 to 20 wt per cent of a metal salt of a dicarboxylic acid, which comprises heating a mixture of (1) a fatty acid having about six to 30 carbon atoms per molecule, (2) a diester of an aliphatic dicarboxylic acid and a monohydric aliphatic alcohol, said diester containing about four to 64 carbon atoms per molecule, and (3) a metal base in a lubricating oil menstruum, for a time and temperature sufficient to form a metal salt of said dicarboxylic acid and metal soap of said fatty acid, and to drive off substantially all the alcohol which forms during said reaction, then cooling said mixture to obtain said grease composition.

Grease Composition and Method of Preparation Thereof, Patent #2,898,297 (J. E. Schott, assignor to Socony Mobil Oil Co., Inc.) A grease composition, comprising: an oil of lubricating viscosity and a mixture (A) of alkaline earth metal soaps and salts therewith, the alkaline earth metals being selected from the group consisting of calcium and a mixture (B) of calcium and barium, not more than about fifteen per cent of barium on a chemical equivalent basis being associated in said mixture (B) with calcium in said soaps and salts, the mixture (A) of said soaps and salts being present in a grease forming quantity, and the metal salts of said mixture (A) being salts of a low molecular weight unsubstituted saturated monocarboxylic acid (I) having from one to six carbon atoms per molecule, and the metal soaps of said mixture (A) being soaps of different acids with said acid (I) as shown in the following tabulation:

Acid	*No. of Carbon Atoms*	*Wt. Per Cent of Total Acids*
(I) Low Molecular Weight	1-6	10-50
(II) Intermediate Molecular Weight	7-12	5-50
(III) High Molecular Weight	at least 13	5-40
(IV) Oil Acids	8-18	25-60

said acid (II) being selected from unsubstituted, monohydroxy-substituted and methyl-substituted saturated aliphatic monocarboxylic acids, said acids (III) being selected from unsubstituted and monohydroxy-substituted saturated aliphatic monocarboxylic acids and monounsaturated aliphatic monocarboxylic acids; and said oil acids being nut oil acids comprising mixtures of acids containing from about eight to 18 carbon atoms per molecule and predominating in C_{12}-C_{14} acids; from about 0.5 to about five per cent by weight (expressed as PbO) of at least one lead compound of at least one of said acids (I) through (IV); and from about one to about ten per cent by weight of an extreme pressure agent containing at least one of the elements selected from the group consisting of chlorine, sulfur and phosphorus.

Ester-Containing Lubricant Compositions, Patent #2,898,299 (W. Lowe, assignor to California Research Corp.) A lubricating oil composition of relatively low corrosivity to sensitive bearing metals, comprising a major proportion of a lubricating oil containing from five to ten per cent by weight of a monoester of a polyhydroxy aliphatic alcohol having four to six hydroxyl groups, the acid radical in said monoester being that of an aliphatic carboxylic acid with an oil-solubilizing chain of at least eight carbon atoms which contains a single olefinic carbon-to-carbon double bond, together with about 1-1/2 per cent to about three per cent of an oil-soluble terpene-P_2S_5 reaction product and a small amount, greater than 0.03 per cent and up to 1.5 per cent within the limits of solubility, of an unsubstituted vicinal dihydroxy aryl compound selected from the group consisting of dihydroxy benzenes and dihydroxy anthraquinones.

High Temperature Lubricating Greases, Patent #2,898,300 (J. H. Norton and S. B. Baker, assignors to Esso Research & Engineering Co.) A lubricant comprising a lubricating oil and a grease-thickening amount of the reaction product of a diisocyanate.

Solid Lubricant Films Having Vitreous Enamel Binders, Patent #2,901,380 (R. E. Crump, assignor to Electrofilm, Inc.) The process of lubricating the irregularized friction surface of a bearing or like metallic element to be subjected to mechanical friction at high temperatures that comprises coating said surface with a uniform

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(see page 506 for Author Index)

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Editor's Note: Vol. 15, No. 3 is no longer available.

Title Index for 1959

Causes and the Control of Electrical Current in Bearings, The, by J. Boyd and H. N. Kaufman ..... 15 (1) pp 18- 22

Centralized Lubrication in the Coal Mining Industry, by J. J. Slomer ..... 15 (7) pp 286-289

Centralized Lubrication in Production Foundries, by W. Kloc ..... 15 (2) pp 62- 63

Conditioning of Vacuum Pump Oils, by G. Topol ..... 15 (12) pp 492-495

Comparison of Dynamic and Static Irradiation Tests of Aircraft Fluids, by R. J. Neely ..... 15 (8) pp 325-327

Designing and Testing Journal Box Seals, by W. L. Stewart ..... 15 (6) pp 242-245

Determining Wear in Automotive Engines, by R. L. Pontius ..... 15 (3) pp 110-115

Development and Testing of Fire-Resistant Hydraulic Fluids for Mine Use, by S. P. Polack ..... 15 (10) pp 403-406

Developments in Railroad Journal Bearings, by M. A. Hanson ..... 15 (11) pp 455-463

Development of Special Lubricants and Lubrication Practices for Small Apparatus, by F. Hardy ..... 15 (8) pp 328-332

Economics of Automatic Power Lubrication as Applied to the Textile Industry, by C. E. Moss ..... 15 (2) pp 58- 61

Economics of Rolling-Contact Bearing Inspection, by C. L. Miller ..... 15 (1) pp 18- 22

Effect of New E-P Lubes on Elastomers for Oil Seals, by J. Murray ..... 15 (4) pp 140-143

Effect of Solid Additives on Fluid Lubricants, by H. L. Herzig ..... 15 (4) pp 152-157

Effect of Thickener-Particle Dimension on Lubricating-Grease Properties, by A. C. Borg and R. H. Leet ..... 15 (11) pp 450-454

Evaluation of Fluids by Hydraulic Pump Tests, by W. M. Schrey ..... 15 (2) pp 64- 67

Gear Rig as an Oil Tester, The, by E. A. Ryder ..... 15 (8) pp 318-324

High Temperature Friction and Wear Properties of Bonded Solid Lubricant Films Containing Lead Monoxide, by R. L. Johnson and H. E. Sliney ..... 15 (12) pp 487-496

Investigation of Factors Affecting High-Temperature Gear Operation, by E. E. Shipley ..... 15 (3) pp 98-103

Investigation of the Mechanism of Tungsten Disulfide Lubrication in Vacuum, by M. T. Lavik, G. E. Gross, and G. W. Vaughn ..... 15 (6) pp 246-249

Laboratory Rating Method for Extreme Pressure Gear Lubricants, A, by A. J. DeArdo and L. B. Sargent, Jr. ..... 15 (9) pp 367-371

Look at the Problem of Gear Lubrication, A, by A. Hundere ..... 15 (9) pp 358-359

Lubrication of Air Cooled and Water Cooled Two-Stroke Cycle Engines, by L. E. Haas 15 (11) pp 436-449

Lubrication Problems in High-Speed Gears, by J. Dern ..... 15 (1) pp 23- 27

Modern Techniques for Spray Lubricating Industrial Gearing, by E. J. Gesdorf .... 15 (10) pp 398-402

Radioactive Determination of Bearing Wear in a Refrigerator Compressor, by G. R. Fox and R. C. Elwell ..... 15 (4) pp 144-151

Radiation Stability of Silicone Greases, by D. J. Fischer, J. F. Zack, Jr. and E. L. Warrick ..... 15 (10) pp 407-409

Recent Developments in the Lubrication of Heavy Duty Industrial Gearing, by G. P. Maurer ..... 15 (9) pp 360-366

Right Lubricant at the Right Price, The, by G. L. Duke ..... 15 (5) pp 213-215

Right Lubricant, The,—Marketing and Technical Service, by H. Muller ..... 15 (5) pp 202-204

Right Place, The,—Plant Practices in Lubrication and Preventive Maintenance, by R. G. Grothus ..... 15 (5) pp 205-209

Right Quantity, The, by C. R. Galbreath.. 15 (5) p 212

Right Time, The,—Mechanized Scheduling of Lubrication, by P. J. Galbreath ..... 15 (5) pp 210-211

Shot Peening in Relation to Gear Tooth Scoring, by J. C. Straub ..... 15 (3) pp 98-103

Some Considerations Relating to Lubrication of Aircraft Turbine Engines, by A. B. Two ..... 15 (7) pp 280-285

Some Factors Affecting Performance of Large Pivoted-Pad Thrust Bearings, by E. C. Kuhn and G. D. Cooper ..... 15 (6) pp 250-255

Specification of Circulating Oil Systems, by J. B. Kirschner ..... 15 (12) pp 484-496

War on Wear, The, by A. F. Brewer ..... 15 (3) pp 104-105

Wright Air Development Center Gear Lubrication Research and Development, by H. R. Smith ..... 15 (7) pp 290-294

Author Index for 1959

Borg, A. C. and Leet, R. H., *Effect of Thickener-Particle Dimensions on Lubricating-Grease Properties* ..... 15 (11) pp 450-454
Boyd, J. and Kaufman, H. N., *The Causes and the Control of Electrical Current in Bearings* ..... 15 (1) pp 28- 35
Brewer, A. F., *The War on Wear* ..... 15 (3) pp 104-105
Cooper, G. D. (see Kuhn-Cooper)
DeArdo, A. J. and Sargent, L. B., *Laboratory Rating Method for Extreme Pressure Gear Lubricants* ..... 15 (9) pp 367-371
Dern, J., *Lubrication Problems in High-Speed Gears* ..... 15 (1) pp 23- 27
Duke, G. L., *The Right Lubricant at the Right Price* ..... 15 (5) pp 213-215
Elwell, R. C. (see Fox-Elwell)
Fischer, D. J., Zack, J. F. Jr. and Warrick, E. L., *Radiation Stability of Silicone Greases* ..... 15 (10) pp 407-409
Fox, G. R. and Elwell, R. C., *Radioactive Determination of Bearing Wear in a Refrigerator Compressor* ..... 15 (4) pp 144-151
Galbreath, C. R., *The Right Quantity* ..... 15 (5) p 212
Galbreath, P. J., *The Right Time—Mechanized Scheduling of Lubrication* ..... 15 (5) pp 210-211
Gesdorf, E. J., *Modern Techniques for Spray Lubricating Industrial Gearing* .... 15 (10) pp 398-402
Gross, G. E. (see Lavik-Gross-Vaughn)
Grothus, R. G., *The Right Place—Plant Practices in Lubrication and Preventive Maintenance* ..... 15 (5) pp 205-209
Hanson, M. A., *Developments in Railroad Journal Bearings* ..... 15 (11) pp 455-463
Hardy, F., *Development of Special Lubricants and Lubrication Practices for Small Apparatus* ..... 15 (8) pp 318-324
Haas, L. E., *Lubrication of Air Cooled and Water Cooled Two-stroke Cycle Engines* 15 (11) pp 436-449
Herzig, H. L., *Effect of Solid Additives on Fluid Lubricants* ..... 15 (4) pp 152-157
Hundere, A., *A Look at the Problem of Gear Lubrication* ..... 15 (9) pp 358-359
Johnson, R. L. and Sliney, H. E., *High-Temperature Friction and Wear Properties of Bonded Solid Lubricant Films Containing Lead Monoxide* ..... 15 (12) pp 487-496
Kaufman, H. N. (see Boyd-Kaufman)
Kirschner, J. B., *Specification of Circulating Oil Systems* ..... 15 (12) pp 484-496
Kloc, W., *Centralized Lubrication in Production Foundries* ..... 15 (2) pp 62- 63
Kuhn, E. C. and Cooper, G. D., *Some Factors Affecting Performance of Large Pivoted-Pad Thrust Bearings* ..... 15 (6) pp 250-255
Lavik, M. T., Gross, G. E. and Vaughn, G. W., *Investigation of the Mechanism of Tungsten Disulfide Lubrication in Vacuum* ..... 15 (6) pp 246-249
Leet, R. H. (see Borg-Leet)
Maurer, G. P., *Recent Developments in the Lubrication of Heavy Duty Industrial Gearing* ..... 15 (9) pp 360-366
Miller, C. L., *Economics of Rolling-Contact Bearing Inspection* ..... 15 (1) pp 18- 22
Moss, C. E., *Economics of Automatic Power Lubrication as Applied to the Textile Industry* ..... 15 (2) pp 58- 61
Muller, H., *The Right Lubricant—Marketing and Technical Service* ..... 15 (5) pp 202-204
Murray, J., *Effect of New E-P Lubes on Elastomers for Oil Seals* ..... 15 (4) pp 140-143
Neely, R. J., *Comparison of Dynamic and Static Irradiation Tests of Aircraft Fluids* 15 (8) pp 325-327
Polack, S. P., *Development and Testing of Fire-Resistant Hydraulic Fluids for Mine Use* ..... 15 (10) pp 403-406
Pontius, R. L., *Determining Wear in Automotive Engines* ..... 15 (3) pp 110-115
Ryder, E. A., *The Gear Rig as an Oil Tester* 15 (8) pp 318-324
Sargent, L. B., Jr. (see DeArdo-Sargent)
Schrey, W. M., *Evaluation of Fluids by Hydraulic Pump Tests* ..... 15 (2) pp 64- 67
Shipley, E. E., *Investigation of Factors Affecting High-Temperature Gear Operation* 15 (3) pp 98-103
Sliney, H. E. (see Johnson-Sliney)
Slomer, J. J., *Centralized Lubrication in the Coal Mining Industry* ..... 15 (7) pp 286-289
Smith, H. R., *The Wright Air Development Center Gear Lubrication Research and Development* ..... 15 (7) pp 290-294
Stewart, W. L., *Designing and Testing Journal Box Seals* ..... 15 (6) pp 242-245
Straub, J. C., *Shot Peening in Relation to Gear Tooth Scoring* ..... 15 (3) pp 106-109
Topol, G., *Conditioning of Vacuum Pumps* 15 (12) pp 492-495
Two, A. B., *Some Consideration Relating to Lubrication of Aircraft Turbine Engines* 15 (7) pp 280-285
Vaughn, G. W. (see Lavik-Gross-Vaughn)
Warrick, E. L. (see Fischer-Zack-Warrick)
Zack, J. F., Jr. (see Fischer-Zack-Warrick)

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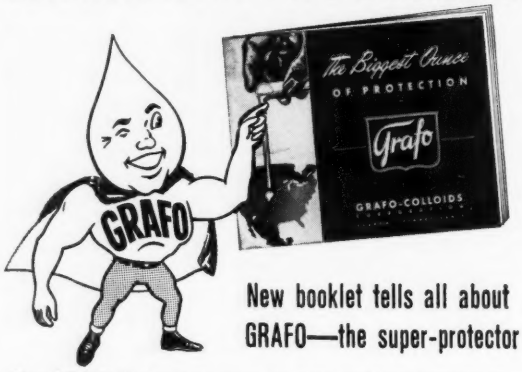

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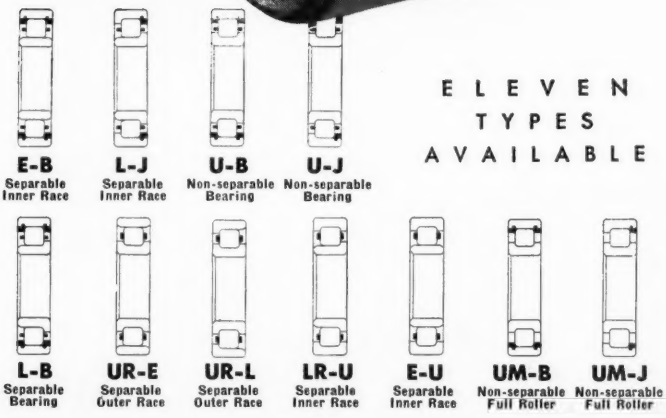

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PATENT ABSTRACTS

(Con't. from p. 504)

mixture of (1) finely divided particles of an inorganic frit fusible to form a binder, and (2) finely divided solid lubricant particles including sufficient graphite to impart lubricity to the subsequently fused film, the weight percentage of lubricant particles in said mixture being in excess of the frit particles therein, heating the coating to a temperature at which the frit particles fuse to form an essentially glassy binder which bonds the graphite-containing lubricant particles therein to the metal surface in a coating in which the graphite has stable lubricity at temperatures in excess of 650F.

Lubricating Compositions, Patent #2,901,-431 (H. M. Trowbridge and H. A. Woods, assignors to Shell Development Co.) A lubricating composition comprising a major proportion of (1) a base mixture of from about 30 to about 40 per cent of a mineral oil and from about 70 to about 60 per cent of asphalt and having incorporated therein (II) from about six per cent to about ten per cent oil-soluble lead naphthenate, from about six per cent to about eight per cent of an oil-soluble polychlornaphtha xanthate containing from about 25 per cent to about 45 per cent chlorine and from about seven per cent to about 15 per cent sulphur in the molecule and from about one per cent to about two per cent butyl stearate.

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Alpha Molykote Corp. 468
Atlantic Refining Co., The 480
Baroid Chemicals, Inc., A Subsidiary of National Lead Co. 473
Bemol, Inc. 428
Bowser, Inc. ..... *
Brooks Oil Co. ..... Second Cover
Cities Service Oil Co. 482
D. A. Stuart Oil Co. ..... *
Emery Industries, Inc. ..... *
Farval Corp., The ..... *
Grafo Colloids Corp. 506
Hodson Corp., The ..... Fourth Cover
Houghton Co., E. F. ..... *
Ironsides, Co., The 430, 431
Joseph Dixon Crucible Co. 427
Lincoln Engineering Co. 465
Lubriplate Div., Fiske Bros. Refining Co. 474
Magie Bros. Oil Co. 504
Manzel Div., Houdaille Industries ..... *
Meyercord Co. ..... *
Morgan Construction Co. 475
National Refining Co. 499
National Seal Div., Federal Mogul-Bower Bearing Co. 471
Norgren Co., C. A. 477
Northern Ordnance, Inc., A Subsidiary of Northern Pump Co. .. 422
Pure Oil Co., The ..... *
R. I. T. A. Corp. ..... *
Reinhold Publishing Corp. ..... *
Research Appliance Co. ..... *
Rollway Bearing Co. 507
Sahara Oil Co. ..... *
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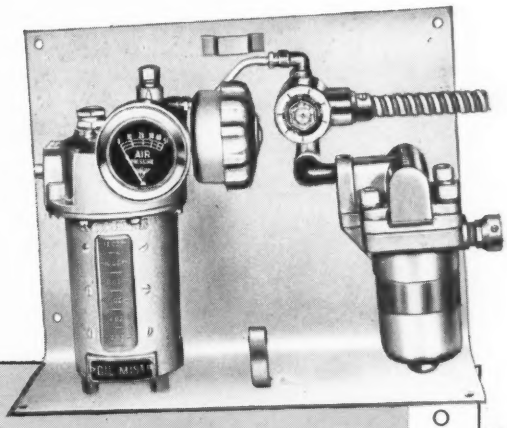

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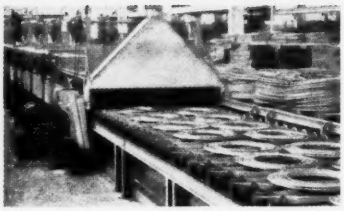

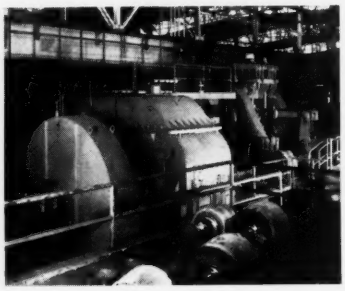

Sintering plant pallet wheel bearings (12 to 1) NOMELT installed 1950

Shaft coupling soaking pit crane (7 to 1) NOMELT installed 1951

Bearings of hot bed dollies (20 to 1) NOMELT installed 1950

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